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Larval Taxonomy of the Troginae in North America with Notes on Biologies and Life Histories (Coleoptera: Scarabaeidae)

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This work forms number 279 of the *Bulletin* series.

FRANK A. TAYLOR
Director, United States National Museum

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Contents

	Page
Introduction	1
Acknowledgments	3
Literature Review	4
Systematics	6
Methods and Materials	9
Collection of Specimens	9
Preservation of Specimens	10
Rearing of Immature Stages	11
Preparation and Study of Specimens	12
Terminology	13
Illustrations	14
General Biology	14
General Description of Immature Stages	16
Life History	17
Keys to the Known Third (Final Stage Larvae)	19
Key to the Genera	19
Key to the Known Third Stage Larvae of *Trox*	19
Key to the Known Third Stage Larvae of *Omorgus*	21
Generic Description of *Trox* Larvae	21
Species Descriptions of *Trox* Larvae	25
Generic Description of *Omorgus* Larvae	39
Species Descriptions of *Omorgus* Larvae	42
Summary	53
Literature Cited	55
Appendix. Symbols Used on Figures	59
Illustrations	61

Larval Taxonomy of the Troginae in North America With Notes on Biologies and Life Histories (Coleoptera: Scarabaeidae) [1]

By CHARLES W. BAKER [2]

Introduction

The subfamily Troginae of the Scarabaeidae is represented by three genera in North America: *Trox*, *Omorgus*, and *Glaresis*, of which *Omorgus* is restored to generic status in this study. Only those species of *Trox* and *Omorgus* which occur in North America are treated in this bulletin. No attempt has been made to separate the species outside of North America into *Trox s. st.* and *Omorgus*. The subfamily contains one other genus, *Cryptogenius*, which is restricted to South America.

The genus *Glaresis* is known from eight species in North America. During this study numerous adults were collected in Oregon, but all attempts to rear the larvae were unsuccessful. The biology of this genus is unknown, and the placement of *Glaresis* within the Troginae has been questioned by Crowson (1955).

The adults and larvae of *Trox* and *Omorgus* can be characterized as facultative animal necrophages. Records indicate that they feed on the remains of a great many terrestrial animals as well as certain aquatic

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[1] Modified from a thesis submitted in partial fulfillment of the requirements for the Ph. D. degree, Department of Entomology, Oregon State University, Corvallis, Oreg.

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forms which are washed ashore. The larvae of several species have been reported feeding on the eggs of the migratory locusts in Asia, Africa, and South America (Denier, 1936; Hayward, 1936; Gardner, 1946; Roffey, 1958). The two genera have a nearly worldwide distribution, being more common in desert and semidesert regions. Forty-two species of *Trox* and *Omorgus* are known at present in North America (Vaurie, 1955, and Howden and Vaurie, 1957). In this report the larvae of 24 species are described, 18 for the first time, and the pertinent morphological structures are illustrated.

At the commencement of this study the larvae of most of the major groups within the Scarabaeoidea were fairly well known. The more comprehensive works include the following: Aphodiinae (Jerath, 1960); Coprinae (Ritcher, 1945c); Geotrupinae (Ritcher, 1947, and Howden, 1955); Melolonthinae (Ritcher, 1949, and Böving on *Phyllophaga* only, 1942); Rutelinae (Ritcher, 1945a); Dynastinae (Ritcher, 1944); Cetoniinae (Ritcher, 1945b); and Hayes (1929) and Böving and Craighead (1931), who were concerned primarily with the taxa above the species level.

Each of the above subfamilies has also been treated by Ritcher (1966) in his comprehensive work on the scarabaeoid larvae of North America, along with additional sections on the Glaphyrinae, Hybosorinae, Pleocominae, Acanthocerinae, and Troginae and the families Lucanidae and Passalidae. Ritcher's treatment of the Troginae is the most extensive to date for North America, and includes figures for the larvae of four species of *Trox*.

This study of the immature stages was undertaken to help clarify the taxonomic status of the Troginae. The placement of the Troginae within the Scarabaeidae has varied with different workers. Certain workers, among them Edwards (1949) and Crowson (1955), have given the group family status. This writer is in agreement with those, among them Arnett (1960), Vaurie (1962), and Ritcher (1966), who would retain the group as a subfamily within the Scarabaeidae. Comparative studies on the larval musculature and larval nervous system are currently in progress and should aid in the systematic placement of the various subfamilies.[3] The high degree of symmetry in the structures of the epipharynx and hypopharynx of *Trox* and *Omorgus* are indicative of the generalized condition. This is in agreement with the findings of Sharp and Muir (1912), who would derive the male aedeagus of all the scarabaeid subfamilies from that of the Troginae.

Prior to this study the larvae of six species of *Trox* and *Omorgus* were known from North America. Four of these six species have been reared

[3] Personal communication with Dr. F. H. Butt, Route 1, Box 47C, Friday Harbor, Wash.

in this investigation along with those of 18 other species. Certain species are distinguished in the adult stage only by characters of the male aedeagus. This, plus the fact that as many as six species may occur together under a single carcass (Spector, 1943), necessitated laboratory rearings to associate the adults and larvae accurately.

Acknowledgments

The writer is especially grateful to Dr. Paul O. Ritcher who suggested the topic, provided the assistantship, and gave most liberally of his time and energies in the capacity of major professor.

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Literature Review

The first description of a *Trox* larva was evidently that of Waterhouse (1836) who described the larva of *Trox arenarius* Fabricius, synonym of *T. scaber* (L.), in a paper on the larvae and pupae of coleopterous insects.

Schiödte (1874) described a single larva of *Trox sabulosus* L. at great length, but according to Meinert (1895) this larva was not that of *sabulosus*. Meinert had collected this larva himself along with a single imago in Algeria and had loaned it to Schiödte. Meinert believed it to be the larva of *T. fabricii* Reiche.

The larva of *T. scaber* (L.) was again described by Xambeau (1892) who later also added a description of the egg and general biology (1895). The larva of *T. perlatus* Goeze was described by Xambeau (1896) in detail, again without any figures.

Fabré (1903) described the habits of the larvae and adults of *T. perlatus* and noted their importance in the conversion of dead animal material.

The larvae of *T. hispidus* Pontoppidan and *T. scaber* (L.) were described by Henriksen (1925). He characterized the larva of *T. hispidus* as possessing a black head capsule and with spinules only on the first fold of abdominal segment seven. The larva of *T. scaber* had a reddish head capsule and with spinules on all three folds of abdominal segment seven.

Hayes (1929) was the first to describe the larva of a species of *Trox* in North America. He figured the lateral aspect of the larva, the cephalic aspect of the head capsule, the epipharynx, and the left prothoracic spiracle of what was probably *T. unistriatus* Beauv.

Böving and Craighead (1931) briefly characterized larvae of the genus *Trox* in a couplet of a key to the families and subfamilies of the Scarabaeoidea. They were the first to recognize the presence of both biforous and cribriform spiracles within the genus. They noted that larvae of *T. scaber* (L.), *T. aequalis* Say, and *T. unistriatus* Beauv. possessed biforous spiracles and the larva of *T. oligonus* Loomis (synonym of *Omorgus texanus* LeConte) possessed cribriform spiracles.

The egg, larva, pupa, and adult of *T. costatus* Wied. were described by Leefmans (1932) from material reared from adults collected in the Mampu Cave in South-Celebes. He experimented with various diets, achieving success with bat guano or dead insects, or a mixture of both.

The larva of the nearly cosmopolitan *T. suberosus* Fab. was briefly described by Sim (1934) from North America. Denier (1936) figured the head capsule and mandibles of *T. suberosus* from South America. Hayward (1936) in the same publication provided photographs of the egg, larva, pupa, and adult of *T. suberosus*. Denier and Hayward were reporting on the significance of *T. suberosus* as a predator of the eggs of the migratory locust.

Van Emden (1941) included the larvae of *T. scaber* and *T. hispidus* in a key to the British lamellicornia larvae. He figured the left antenna of *T. scaber* and noted that in his larvae the spinules did not occur posterior to the fold of abdominal segment seven which bears the long setae. He further noted that whereas he regarded this as the second fold, Henriksen (1925) evidently considered it as the third fold. The area in contention above is referred to in this paper as dorsal lobe two (DL2), and is the median lobe of abdominal segment seven, beyond which the spinules do not occur in this species.

The larvae of *T. scaber* and *T. hispidus* also were included by Paulian (1943) in a key to the scarabaeoid larvae of France, wherein he separated the larvae of these species in the same manner as van Emden (1941). His figure of the epipharynx of *T. scaber* is somewhat different, however, from that of my material.

Gardner (1946) briefly described the larva of *T. procerus* Harold from India. The larva of *T. procerus* was described in greater detail by van Emden (1948). Van Emden also described the larva of *T. costatus* Wied. and figured the third stage larva of *T. procerus* and spiracles of *T. scaber*, *T. procerus*, and *T. costatus*. He illustrated the supporting struts beneath the respiratory plates since they appeared to be different in the species he had at hand. In this study the struts have been found to be too variable to allow separation at the species level.

Peterson (1951) characterized *Trox* larvae at the generic level for North America and commented on the general biology of the group.

Paulian (1956) again separated the larvae of *Trox* from those of other scarabaeids of France. He figured the entire larva, epipharynx, and terminal segments (ventral aspect) of *T. perlatus* F.

The larva of *T. sabulosus* L. was briefly characterized by Panin (1957), and the terminal abdominal segment (posterior view) and prothoracic leg figured. His figures are so distinctly different from all known figures of *Trox* larvae that it is quite possible that they are actually those of some other genus.

Roffey (1958) described the larva and biology of *T. procerus* Har. in great detail. From his figures, however, it would appear that Roffey was actually working with more than one species.

The most comprehensive treatment of *Trox* larvae to date is that of Ritcher (1966), wherein he has presented a key for the separation of the larvae of the *suberosus* group as recognized by Erichson (1847)

and LeConte (1854). He is the first to have recognized the difference in the pattern of the stridulatory teeth on the maxillae of the two groups.

Incertae Sedis

Perris (1877) described the larva of *Trox hispidus* Laichart. He figured the left maxilla, left mandible (dorsal aspect), right mandible (lateral aspect), left antenna, posterior segments (posterior view), and leg of *T. hispidus*. The figures, however, are not very detailed.

Systematics

A comprehensive monograph on the adults of the genus *Trox* in North America was published by Vaurie in 1955. Vaurie separated the species of *Trox* into five groups: *scaber*, *terrestris*, *tuberculatus*, *unistriatus*, and *suberosus*. A checklist of the species grouped according to Vaurie is presented in table 1. Species whose larvae are now known are marked with an asterisk.

Two additional species were described by Howden and Vaurie in 1957. These species were *T. floridanus* and *T. howelli*, and they are included in their respective groups in table 1.

Other major treatments of the adults of *Trox* include the following: Palearctic Region (Balthasar, 1936), Africa (Haaf, 1953), Africa and Asia (Haaf, 1954a), Australia (Haaf, 1954b), and South America (Vaurie, 1962).

Vaurie (1955) recognized that the *suberosus* group was quite distinct from the other four groups in North America and presented a table listing ten characters which distinguished the adults of this group from those of the other groups.

On the basis of the larval systematics and recent work on the morphology and cytogenetics of the adults, the writer has restored *Omorgus* to generic status to include those species in Vaurie's *suberosus* group in North America. The genus *Omorgus* was first proposed by Erichson (1847). *Trox suberosus* Fabricius was later designated by Lacordaire (1856) as the type. LeConte (1854) followed Erichson in this separation, placing 11 species from North America in the genus. Subsequent workers, however, considered *Omorgus* as synonymous with *Trox*, as a subgenus of *Trox*, or as the *suberosus* group within the genus *Trox*. The characters supporting the above separation are presented in table 2. These are in addition to those characters listed by Vaurie (1955) in her monograph on the adults. Distinguishing characters are present in all life stages: egg, larva, pupa, and adult. The writer makes

TABLE 1.—*List of species of* Trox *in North America after Vaurie (1955) and Howden and Vaurie (1957). The species of the* suberosus *group have been placed in the genus* Omorgus *as a result of this and other recent investigations. Species whose larvae are now known are marked by an asterisk, and the third stage larva of each is described in this study.*

1. *scaber* group
   - **T. scaber* (Linnaeus)
   - **T. aequalis* Say
   - *T. affinis* Robinson
   - **T. fascifer* LeConte
   - *T. striatus* Melsheimer
   - *T. laticollis* LeConte
   - **T. atrox* LeConte

2. *terrestris* group
   - *T. hamatus* Robinson
   - *T. spinulosus simi* Robinson
   - *T. s. spinulosus* Robinson
   - **T. s. dentibius* Robinson
   - **T. foveicollis* Harold
   - *T. terrestris* Say
   - **T. frontera* Vaurie

3. *tuberculatus* group
   - **T. sonorae* LeConte
   - *T. contractus* Robinson
   - **T. robinsoni* Vaurie
   - *T. gemmulatus* Horn
   - *T. acanthinus* Harold
   - **T. tuberculatus* (DeGeer)
   - *T. floridanus* Howden and Vaurie
   - **T. plicatus* Robinson

4. *unistriatus* group
   - **T. variolatus* Melsheimer
   - **T. sordidus* LeConte
   - *T. capillaris* Say
   - **T. unistriatus* Beauvois

5. *suberosus* group
   - *T. tytus* Robinson
   - *T. howelli* Howden and Vaurie
   - **T. suberosus* Fabricius
   - **T. rubricans* Robinson
   - **T. carinatus* Loomis
   - *T. tomentosus* Robinson
   - **T. monachus* Herbst
   - **T. fuliginosus* Robinson
   - *T. scabrosus* Beauvois
   - **T. asper* (LeConte)
   - **T. punctatus* Germar
   - **T. inflatus* Loomis
   - *T. tesselatus* (LeConte)
   - *T. nodosus* Robinson
   - **T. texanus* (LeConte)
   - *T. umbonatus* (LeConte)
   - **T. scutellaris* Say

no attempt at this time to separate the species on a worldwide basis. It may well be that there are more than two genera worldwide.

The characters of the immature stages of the genus *Trox* lend support to Vaurie's recognition of the *scaber* and *terrestris* groups for the adults. Larvae of the *scaber* group have an epipharynx with four smaller sensory spots distad of the two larger, setiferous sensory spots on the sensory area of the haptomerum and only two sensory spots distad of the slightly arching, transverse row of sensory spots on the pedium. The *terrestris*, *tuberculatus*, and *unistriatus* groups have only two smaller sensory spots distad of the two larger, setiferous sensory spots on the sensory area of the haptomerum and four sensory spots distad of the slightly arching, transverse row of sensory spots on the pedium. The

TABLE 2.—*Morphological differences between* Trox *and* Omorgus *(characters pertain to larvae unless otherwise noted).*

Trox	*Omorgus*
1. Spiracles biforous.	1. Spiracles cribriform.
2. Maxillae with curved, diffuse double row or curved patch of stridulatory teeth.	2. Maxillae with single, straight row of stridulatory teeth.
3. Chromosomes metacentric.[1]	3. Chromosomes acrocentric.
4. Antenna with prominent sensory cone on distal end of segment 2.	4. Antenna without sensory cone; with slightly concave sensory area.
5. Frontocylpeal suture indistinct.	5. Frontocylpeal suture distinct.
6. Extruded rectal membrane with elongate, continuous sclerotized areas.	6. Extruded rectal membrane with oval, isolated sclerotized areas.
7. Left mandible with two teeth (S_3 and S_4) on median border proximad of scissorial notch.	7. Left mandible with three teeth (S_3, S_4, and S_5) on median border proximad of scissorial notch.
8. Each anterior angle of frons with one seta.	8. Each anterior angle of frons with three or more setae.
9. Tibiotarsus with two whorls of six setae each.	9. Tibiotarsus with terminal whorl of six setae plus about 8 to 22 scattered setae proximad of whorl.
10. Prothorax with two small lateral lobes.	10. Prothorax with single large lateral lobe.
11. Prothorax without setae on dorsal, nonsclerotized area between shields.	11. Prothorax with setae on dorsal, nonsclerotized area between shields.
12. DL2 of mesothorax without setae.	12. DL2 of mesothorax with setae.
13. Haptolachus without sclerotized sense cone.	13. Haptolachus with sclerotized sense cone.
14. Glossa with four or five setae on dorsal aspect.	14. Glossa with eight or more setae on dorsal aspect.
15. Rows of phobae on proximal area of hypopharynx curving medially to join at base.	15. Rows of phobae on proximal area of hypopharynx not curving medially to join at base, widely separated at base.
16. Pupa with two terminal claws on prothoracic legs.	16. Pupa without terminal claws on prothoracic legs.
17. Adult female reproductive system with six short ovarioles on each side.	17. Adult female reproductive system with three long ovarioles on each side.

[1] Testes from males of known ages were used by Dr. N. Virkki, University of Puerto Rico, Agricultural Experimental Station, for the studies of the chromosomes.

terrestris group is distinguished by having six sensory pegs on the distal portion of the terminal segment of the antenna (figs. 44 and 47). The other three groups have five sensory pegs and one long sensory seta (figs. 45 and 46).

It appears that Vaurie's *tuberculatus* and *unistriatus* groups are closely allied on the basis of larval characteristics. The larvae of these groups could not be separated one from the other, and several larvae of the *tuberculatus* group are so similar that they have been brought out together in the same key couplet.

The larvae of the genus *Omorgus* are generally much larger than those of *Trox*, and with a few exceptions are much more setiferous. Certain of the species are quite distinct and easily recognized. Others, however, are so similar that the writer cannot separate them by reliable key characters.

Species groups within the genus *Omorgus* are evident on the basis of larval characters. *O. monachus* and *O. fuliginosus* are the only species to possess spinules but no setae on DL1 of the first four abdominal segments. All other species possess both. *O. rubricans* and *O. texanus* are distinguished from the other species by the large concavity mediad of the eyespot and by the transverse row of caudally directed phobae at the base of the smaller distal portion of the hypopharynx. The larvae of the other six species of *Omorgus* are apparently much more homogeneous.

Methods and Materials

Collection of Specimens

The four species of *Trox* and *Omorgus* which are known to occur in Oregon were collected at black light and a method for rearing the larvae was worked out during the summer of 1963. The majority of the remaining species (15) were collected at black light or at carcasses on an extended trip through Arizona, New Mexico, and Texas during June and July of 1964. Other species were collected by interested workers and airmailed to Corvallis, Oreg., for rearing. Two shipments of specimens were received from South America, but all specimens died en route.[4] Additional preserved larvae were obtained from the United States National Museum and Dr. P. O. Ritcher.

The black light setup consisted of one 15-watt General Electric F15T8–BL tube placed on each side of a cloth sheet which was sus-

[4] Transportation or shipment of living specimens was done with State and Federal permission.

pended on a portable metal stand at a height of 5 feet. One additional sheet was placed flat on the ground on each side of the vertical sheet to silhouette the smaller specimens. The lights were powered by a 12-volt model 50–167 Terado Power inverter connected to a 12-volt car battery.

A trapline of mammal and bird carcasses was set out in June and July of 1964. The trapline commenced at Nogales, Ariz., and extended eastward through southern Arizona, New Mexico, and central Texas, terminating at the town of Uvalde, Tex. The return trip to check the trapline was made during the last two weeks of July. Additional carcasses along the trapline and in eastern and southern Texas were investigated. The carcasses proved to be more productive than the black light for the collection of adult *Trox* and *Omorgus*.

The carcass was turned first and all readily visible specimens of *Trox* retrieved. The debris beneath the carcass and the soil to a depth of about 18 inches were passed through window screening (14- by 18-inch mesh). The material that failed to pass was spread out on a piece of canvass sheeting in the sun. The heat from the sun served to "activate" the death feigning, dirt-coated adults so that they could be distinguished from the debris.

Representative adults and larvae were dropped into KAA solution in the field or placed in individual salve tins for rearing or later fixation. Larvae of *Omorgus* were placed one to a tin since they are pungacious, whereas several larvae of *Trox*, especially the smaller species, could be placed in one tin. The adults that were later used for laboratory rearings were placed in Gerber baby food jars (140-ml. size) with perforated screw-cap lids. Each jar was about two-thirds filled with screened sand and a small amount of food. The number of specimens per jar varied from about 10 for those 10 to 12 mm. long to about 50 of the 5- to 7-mm. length. The jars were stored in styrofoam coolers containing a 2-quart can of ice which was insulated by 1 inch of folded newspaper. This arrangement maintained a temperature of about 60 to 70 degrees Fahrenheit within the cooler. About 1,000 live adults were returned to Corvallis by this method.

Preservation of Specimens

The larvae were preserved by two methods. In the first method the larvae were placed in a solution of KAA (one part kerosene, one part glacial acetic acid, nine parts 95-percent ethyl alcohol) for 48 hours and then transferred to 95-percent ethyl alcohol for storage. In the second method the larvae were placed in gently boiling water for 3 minutes after which the beaker was removed from the heat and the contents allowed to cool. When cool, the larvae were transferred to

70-percent ethyl alcohol for storage. Best results with KAA were obtained with recently moulted larvae. Late third stage larvae of *Omorgus* usually shriveled instead of expanding when placed in KAA. Best results with boiling were obtained with larvae which had ceased feeding but had not yet become prepupae. The digestive tract of actively feeding larvae often burst when the larvae were boiled, releasing the gut contents into the hemocoel. This produced a blackish specimen, whereas the desired state is straw yellow to white.

During fixation the anal area of most specimens becomes greatly expanded, exposing the lining of the rectum. The pattern of the sclerotized areas on this inflated, membranous lining of the rectum is quite different for *Trox* and *Omorgus* (figs. 50 and 52).

Rearing of Immature Stages

The method used for rearing the larvae was adapted from that previously used by Ritcher.[5] Individual rearings were carried out with all species that could be confused on the basis of external morphology. This necessitated the sexing of specimens, since only two species are sexually dimorphic. The specimen was inactivated with carbon dioxide and placed under a binocular stereomicroscope. A pair of No. 5 jeweler's forceps was used to open the urogenital orifice so that the genitalia could be viewed. After sexing, the females were placed in separate rearing containers.

The rearing containers varied in size from a pint jar to a gallon jar depending on the size of the species. The jar was about two-thirds filled with damp, screened sand overlaid with food. The food consisted of a mixture of cow hair, deer hair, sheep's wool, rabbit hair and skin, and pheasant, quail, and dove feathers and skin. Great care had to be exercised to insure that the food source was free of insecticide. The jar was wrapped with a black plastic sleeve that could be removed to check for eggs or larval burrows against the sides or bottom. The jars were capped to keep out pests such as dermestids and tineids and to maintain a high level of humidity.

The eggs and larvae were removed at about 14-day intervals to individual 2-ounce salve boxes. A representative portion of the F_1 generation was preserved as larvae. The suspected identity of the female was then confirmed by dissection of the male genitalia of adults of the F_1 generation.

Individual larvae were reared in salve boxes filled with damp, screened sand with a small amount of food on one side. The develop-

[5] Personal communication with Dr. P. O. Ritcher wherein he described the method he devised for the rearing of *Trox* larvae after observing how easily Dr. M. A. Cazier reared the larvae of one Southwestern species.

ment of these larvae was checked periodically. It was found that the development was retarded, however, whenever the larvae were disturbed. Also, larvae left in the jars developed more rapidly than those placed in the salve boxes. All rearings were carried out at room temperature.

Preparation and Study of Specimens

A binocular stereomicroscope with an ocular micrometer was used for the head capsule measurements. All measurements were made on specimens submerged in alcohol. The greatest width of the head capsule was usually found to be at the eyespots or just posterior to the eyespots. The measurements are presented under each species description with LI indicating first stage larva, LII indicating second stage larva, and LIII indicating third stage larva. The majority of the descriptive work was done using a binocular stereomicroscope and magnifications of 10× to 90×. A binocular compound microscope was used to observe the details of structures such as the macrosensilla and antennal sensory pegs at magnifications of 100× and 430×.

Permanent whole mount slides of the antennae, hypopharynx, epipharynx, and maxillae were made for all species. The dissected structures usually were mounted directly from 70-percent ethyl alcohol into Hoyer's mounting medium. Three small pieces of modeling clay were placed about the mounting medium in a triangle, and the cover slip placed on top of them. Pressure was then carefully applied to the cover slip until the clay particles were flattened to a level where the cover slip was in close contact with the mounted material. Heavily pigmented or sclerotized structures were partially cleared in a solution of hot, 10-percent KOH. These structures were removed to 70-percent ethyl alcohol for several hours before mounting in Hoyer's.

Formula for Hoyer's Mounting Medium

50 grams distilled water
30 grams gum arabic (clear crystals)
200 grams chloral hydrate
20 grams glycerin
The ingredients should be mixed at
room temperature in the above sequence.

It is unfortunate that many characters of taxonomic importance are located on the mouthparts of scarabaeid larvae since these areas are subject to considerable abrasion. The reader is cautioned to take into consideration the fact that these structures may be broken, ground down, or otherwise damaged in specimens of any instar which have

not recently moulted. The epipharynx and hypopharynx of many *Trox* and *Omorgus* evidenced areas which had been so damaged. Often many dissections were necessary to find an undamaged epipharynx or hypopharynx.

Terminology

The terminology used in this report is essentially that employed by Böving (1936 and 1942) and Ritcher (1966). Where necessary a few additional terms have been used to facilitate the description of certain structures and areas.

The term "fused phobal mass" is used to denote the large, coalesced group of phobae located on each side of the pedium slightly anterior to the tormae (fig. 2).

The terms "subtorma" and "subapotorma" have been used to aid in the description of the hypopharynx. In each case the prefix "sub" has been affixed to the term used for a similar structure occurring on the epipharynx. The prefix "sub" is used as these structures occur on the dorsal surface of the submentum and ventral to similar structures of the epipharynx.

The term "subtorma" refers to the heavily sclerotized, transverse, curved process located near the proximal border of the hypopharynx. The subtormae of *Trox* and *Omorgus* are nearly symmetrical and have strongly produced anterior and posterior projections at their outer margins. The subtormae are usually joined medially (figs. 10, 12, and 19).

The term "subapotorma" refers to the heavily sclerotized process extending forward from the subtorma on each side mediad of the longitudinal row of inwardly directed, closely set phobae of the hypopharynx (figs. 10, 12, and 19).

The various lobes of the thorax and abdomen of the larvae have been assigned names in this dissertation which differ from those generally employed in the past. Most workers have adapted the terminology normally used for the sclerites of the adult insect thorax for use on the larvae. Terms such as "prescutum," "scutum," "scutellum," et cetera, have been used to refer to the different lobes of the segments of the thorax and abdomen of soft bodied larvae. This writer concurs with Butt, however, in the usage of a simplified terminology for the larvae distinct from that employed for the well-defined sclerites of the adults.[6] Butt in his work on the larval musculature of the Scarabaeoidea has restricted his approach to a recognition of lobes and of the folds which set off these lobes. He has recognized the following for the abdominal segments of the larvae: dorsal lobe one (DL1), dorsal lobe two (DL2),

[6] Personal communication with Dr. F. H. Butt.

dorsal lobe three (DL3), and spiracular lobe (SL) (figs. 33 and 35).

I have followed the above designation plus the following: lateral lobe one (LL1), lateral lobe two (LL2), and lateral lobe three (LL3) for the three main lobes of the lateral area (figs. 33 and 35); and ventral lobe one (VL1), ventral lobe two (VL2), and ventral lobe three (VL3) for the three main lobes of the ventral region (fig. 28).

In addition I have designated three subdivisions of DL3 on abdominal segments one through six as DL3a, DL3b, and DL3c (fig. 33). The same terminology has been applied to the lobes of the thorax with the exception that there are usually only one or two such lobes per segment on the thorax.

Illustrations

The figures were done with the aid of a squared grid in the ocular of a binocular stereomicroscope, using a Bausch and Lomb microprojector, or freehand for those which were diagrammatic. Sclerotized areas are indicated by stippling and the heavier the degree of sclerotization or pigmentation, the heavier the stippling. The degree of pigmentation of the different areas was found to vary directly with the degree of sclerotization.

Broken lines on the figures of the epipharynx are used to indicate a zone of transition in texture. Broken lines on the thoracic and abdominal figures denote secondary folds, whereas solid lines demark the primary folds of the different segments.

General Biology

Adults and larvae of *Trox* and *Omorgus* usually are found associated with animal remains (insects, fish, amphibians, reptiles, birds, mammals). They are commonly found as one of the last visitors of mammal and bird carcasses, or in the nests of birds and burrows of mammals, especially those in which there is an accumulation of fur or feathers. Vaurie (1955) in her monograph on the group included a section on biology and information on the individual species where known.

The adults of the North American species vary in size from about 5 mm. to 19 mm. Most species have rough dorsal surfaces, and they are usually covered with a crusty induement consisting mainly of particles of mud plus small pieces of debris from the media in which they live. At least a portion of this induement is attained as the teneral adults make their way from the pupal cells to the soil surface. When disturbed, the adults rapidly deflex the head and pull all the legs tight against the body in such a way that neither head nor legs are visible from above. In this position and protectively covered as they are by

the inducment, the adults look very much like small clods of soil or a piece of the carcass or surrounding debris. The adults of some species will remain motionless like this for as long as an hour; *T. atrox*, however, will move again within 2 or 3 minutes.

The larger species, especially those of *Omorgus*, are usually associated with carcasses, whereas the smaller species, particularly those of the *scaber* group, are more often found in nests or burrows. Certain species apparently are found only in nest and burrow habitats. Hicks (1959) lists over 100 records of *Trox* spp. taken in bird's nests on a world-wide basis.

The carcass-feeding forms appear to prefer dried carcasses that have been reduced to skin, dermal derivatives, and bone. These carcasses are particularly attractive after a heavy rain. This is due perhaps to the increased odor produced by the wet carcass. Heavy rains also insure the presence of sufficient soil moisture for the development of the larvae in the soil beneath the carcass. As many as five species of *Trox* and *Omorgus* have been collected by the writer beneath a single carcass. The larger species were observed feeding on the hooves, skin, hair, and tendons, whereas the smaller species appeared to be associated with the hair and smaller remains.

The females of the larger species generally burrow to a greater depth to lay their eggs than do females of the smaller species. A female of the small *T. scaber* deposits her eggs at a depth of about 1.0 to 3.0 mm.; a female of the very large *O. texanus* will burrow to a depth of about 6.0 to 10.0 inches for oviposition. The eggs are usually deposited in groups of about three or four. The species laying very large eggs may lay only one or two eggs at a time. The soil about the eggs apparently is specially treated by the female since it evidences a slightly different consistency.

The larvae burrow vertically to the surface shortly after hatching and commence to feed. The larvae are capable of rapid forward or backward movement within their burrows, and when disturbed they rapidly retreat to the bottoms of their burrows. The larvae pass through three instars having a total duration of about 4 weeks. The active third instar usually burrows slightly deeper before constructing the pupal cell. Nest inhabiting species are known to construct pupal "cocoons" within the walls of the nest (Robinson, *in litt.*, cited in Vaurie, 1955), utilizing debris and hair to form the wall of the "cocoon." *Trox scaber* was observed to do this in the laboratory when liberal amounts of hair were intermixed in the soil of the rearing container.

The pupal stage averages about 9 to 15 days. The callow adults remain in their pupal cells for at least 2 to 3 days during which time they undergo hardening and darkening processes. Some species probably pass the winter or summer within the pupal cell. Others evidently emerge to feed before hibernating or aestivating.

There is probably only one generation per year, with the adult as the usual overwintering stage. It is possible that some species also overwinter as third instar larvae. For example, the writer received a group of *T. plicatus* from N. McFarland which were collected on August 5, 1963, near Portal, Ariz. Larvae reared from these adults did not pupate until April 1964.

The timing of the life cycle appears to vary with the species and climatic conditions. Those species occurring in Oregon appear to be restricted to spring and early summer in their reproductive activities. Certain Southwestern species are active during mid and late summer, but others such as *T. frontera* appear to have an early spring activity period and then oversummer as quiescent adults deep within the soil.

It appears that spermatogenesis starts late in the adult life of *Trox* and *Omorgus*.[7] Mating of these beetles probably occurs, therefore, at the onset of their next period of activity; early spring for those species overwintering as inactive adults.

General Description of Immature Stages

The immature stages consist of the following: egg, first stage larva, second stage larva, third stage larva, and pupa. The eggs are soft and shining milk white when first deposited, but decrease in luster with advancing development. As with the eggs of other scarabaeids, the eggs of *Trox* and *Omorgus* expand in size after oviposition. They vary in size from 1.10 mm. by 0.85 mm. for *T. scaber* to 4.0 mm. by 7.0 mm. for *O. texanus* at a time shortly before hatching. The eggs of *Trox* retain their spherical shape during development, but those of *Omorgus* take on a reniform shape late in their development (fig. 23).

First stage larvae have the fewest setae per given area of all three larval stages. Second stage larvae have many more setae per given area, but still slightly fewer than the definitive number. Figures 16, 17, and 18 show the relative sizes of the three instars and their general form. The larvae vary in color from white to straw yellow, with the color becoming more pronounced with age. Color is most easily ascertained in late third stage larvae which have voided the contents of their alimentary tracts. The larvae of *Trox* and *Omorgus* are quite variable even within the species with respect to body length. A tentative range for body length may be arrived at, however, if one multiplies the head width of the *Omorgus* species by a factor of 3.5 and 5.0 and the head width of the *Trox* species by a factor of 4.5 and 7.5.

[7] Personal communication from Dr. N. Virkki, University of Puerto Rico, Agricultural Experimental Station, February 14, 1964.

The larvae of *Trox* and *Omorgus* have a large, strongly pigmented cranium which varies in color from orange, red, or brown to dark red brown or black. The cranium is slightly reticulate posteriorly and slightly rugose anteriorly and bears a small number of setae in a well-defined pattern. The cranium also is strongly pitted in some species. The sclerotized shield of the prothorax is usually of a color similar to that of the cranium.

The larvae bear two specialized structures which are probably egg bursters on DL1 of the mesothorax and metathorax. The bursters are thorn-like sclerotized projections bearing a short seta on the posterior side near the base (fig. 15). They are located on each side of the dorsal median line slightly anterior to the transverse row of setae. The bursters are larger on the metathorax and they are generally larger on larvae of *Trox* than on larvae of *Omorgus*. The egg bursters are present in second and third stage larvae in a much reduced condition.

The pupae are of the exarate type (figs. 32 and 34) and are sexually dimorphic. The ventral aspect of abdominal segment eight in the females has two lobes flanking a slightly depressed median area (fig. 13). The ventral aspect of abdominal segment eight of the males has two lateral lobes flanking a median lobe (fig. 14). The setal pattern anterior to the lobes is also slightly different for the males and females (figs. 13 and 14). Pupae of the two genera are separable in that the more slender prothoracic legs of *Trox* bear a pair of terminal claws which are lacking on the stouter prothoracic legs of *Omorgus* (figs. 30 and 31).

Life History

The following life history was worked out for *Trox scaber* (L.) in the laboratory, at room tempeature. The female from which all the larvae were reared was collected on April 26, 1965, at black light about 10 miles north of Corvallis, Oreg., by the writer.

This female was placed in a pint jar two-thirds filled with screened sand which was overlaid with about one-half inch of hair and feathers. The female deposited a total of 11 eggs during the first 7 days of captivity. These were deposited in groups of three and four at 2- to 3-day intervals. Egg production then decreased to an average of three to four eggs about every 5 days during the next 16 days. It then decreased again in July and ceased altogether about July 15, 1965. A total of 58 eggs and larvae was retrieved from the container.

The female oviposited at a depth of about 1 to 3 mm. beneath the food source. The larvae hatched about 8 to 9 days after oviposition. First stage larvae burrowed to the surface, where they fed in a well-

defined vertical burrow. The first stadium averaged about 7 days. Second stage larvae resumed feeding very soon after moulting. They fed actively throughout the second stadium which averaged about 7 to 8 days. The moults from first to second and from second to third stage larvae evidently took place in the burrow proper since no special cells were found. The third stage larvae also resumed feeding very soon after moulting; however, after about 7 to 8 days they ceased feeding and usually burrowed slightly deeper into the soil, where they constructed a smooth-walled pupal cell. The larvae either voided the contents of their digestive tracts just prior to construction of the pupal cell or during construction, using the voided material to help firm up the walls of the cell. Shortly after construction of the pupal cell the third stage larvae entered the inactive prepupal stage. This stage had a duration of about 7 days, with the only movement being a wriggling of the prepupae, especially when disturbed. During this period the prepupae underwent a shortening and a thickening. The pupal stage had a duration of about 8 to 9 days. The moult from pupa to adult always occurred while the pupa rested on its venter. After ecdysis the adults remained quiescent for several days before leaving the pupal cell. During this quiescent period the adults underwent the normal hardening and darkening processes.

Total time from egg to adult in the laboratory varied from about 44 to 50 days. The larvae hatching from the first clutches of eggs appeared to have greater vitality and to develop more rapidly than those hatching from eggs oviposited late in the reproductive cycle of the female.

One adult *T. scaber*, one first instar larva, and 11 third instar larvae were collected by J. F. Cornell from a Berlese sample collected June 27, 1966, about 14 miles south of Corvallis, Oreg. The sample consisted of the nest material of a wood rat (*Neotoma* sp.) and the duff and several inches of soil from beneath the nest. The stage of development and size of the larvae compared quite well with the laboratory-derived life history data.

A single female of *T. fascifer* LeConte was collected May 18, 1963, at black light in Corvallis, Oreg., by the writer. A total of 60 eggs and larvae was retrieved from the container housing this specimen. This species also was observed to oviposit at a depth of about 1 to 3 mm. It ceased ovipositing by July 17, 1963. The total time required for the development of the larvae closely approximated that for *T. scaber*. The recorded time for the pupal stage was longer, averaging 11 days.

The females of the genus *Omorgus* were observed to enter the soil to a depth of about 4 to 10 inches in order to oviposit. They usually deposited a clutch of four eggs, less commonly three eggs. The larvae hatched after about 8 days and pupated about 22 days later. The average duration of the pupal stage for three species (*O. monachus*, *O. carinatus*, *O. asper*) was 14 to 15 days at room temperature.

The above life history data are similar to those of Leefmans (1932). According to his data, eggs of *T. costatus* Wied. required about 8 days before hatching occurred. The larvae pupated about 31 to 42 days later. The pupal stage had a duration of about 11 to 12 days, and the adult quiescent period varied from 10 to 13 days.

Keys to the Known Third (Final) Stage Larvae

The keys presented below separate the final or third stage larvae of 14 species and four groups of two and three species each. The four species groups have the following compositions: *scaber* and *fascifer; spinulosus dentibius* and *foveicollis; plicatus, robinsoni*, and *tuberculatus; asper, punctatus*, and *carinatus*. The known ranges of certain of the species in the above groups are mutually exclusive, at least in part. The larvae could be tentatively identified, therefore, on this basis. See Vaurie (1955), Howden and Vaurie (1957) and Vaurie (1958) for the known ranges of the species of *Trox* and *Omorgus* in North America.

KEY TO THE GENERA

1. Spiracles biforous (fig. 56). Antenna with distal sensory cone on segment 2 (fig. 20). Maxillary stridulatory area with curved double row or patch of stridulatory teeth (figs. 41 and 42). *Trox*
   Spiracles cribriform (fig. 59). Antenna without sensory cone, with slightly concave distal sensory area on segment 2 (fig. 21). Maxillary stridulatory area with single straight row of stridulatory teeth (fig. 49) . . . . . *Omorgus*

KEY TO THE KNOWN THIRD STAGE LARVAE OF *TROX*

1. Epipharynx with 4 smaller sensory spots distad of 2 larger, setiferous sensory spots on haptomerum (figs. 3, 6, and 8). With only 2 sensory spots on pedium distad of slightly arching, transverse row of sensory spots (figs. 3, 6, and 8) 2
   Epipharynx with 2 smaller sensory spots distad of 2 larger, setiferous sensory spots on haptomerum (figs. 2, 4, 5, and 7). With 4 sensory spots on pedium distad of slightly arching, transverse row of sensory spots (figs. 2, 4, 5, and 7) 4
2. Dorsal lobe 1 (DL1) of abdominal segments 1 to 4 with transverse, irregular double row of about 25 to 40 spinules (fig. 37). With prominent median epicranial setae (fig. 1) . . . . . *atrox*

Dorsal lobe 1 (DL1) of abdominal segments 1 to 4 with single transverse row of about 10 to 14 spinules (fig. 36). Median epicranial setae very small or absent 3

3. Median group of phobae on pedium usually restricted to right side (fig. 6). Frons broadly rounded posteriorly and very prominently pitted (fig. 54) . . . . . *aequalis*

Median group of phobae on pedium not restricted to right side (figs. 3 and 8). Frons more abruptly narrowed posteriorly and less prominently pitted (figs. 55 and 58) . . *scaber* and *fascifer*

4. Dorsal lobe 1 (DL1) of abdominal segments 1 to 4 with single transverse row of about 12 to 20 spinules (fig. 36) 5

Dorsal lobe 1 (DL1) of abdominal segments 1 to 4 with transverse, irregular double row or transverse band of about 20 to 50 spinules (fig. 37) 6

5. Head capsule width usually greater than 1.90 mm. With 1 long sensory seta and 5 sensory pegs at distal end of segment 3 of antenna (figs. 45 and 46) . . . . . *variolatus*

Head capsule width less than 1.90 mm. With 6 sensory pegs at end of segment 3 of antenna, lack long sensory seta (figs. 44 and 47) . . . . . *spinulosus dentibius* and *foveicollis*

6. Cranium light orange to light yellow brown. With 6 sensory pegs at end of segment 3 of antenna, lacks long sensory seta (fig. 44) . . . . . *frontera*

Cranium red brown to black. With long sensory seta and 5 sensory pegs at end of segment 3 of antenna (fig. 45) 7

7. Head capsule red brown; width usually less than 2.30 mm. Lateral lobe 3 of abdominal segments 7 and 8 without setae . . *sordidus*

Head capsule red brown to black; width usually greater than 2.35 mm. Lateral lobe 3 of abdominal segments 7 and 8 with at least 1 seta each (fig. 22) 8

8. Lateral margins of epipharynx with pronounced asperites (fig. 7). Epipharynx with at least 4 setae on each side caudolaterad of sensory area of haptomerum (fig. 7) . . . . . *unistriatus*

Lateral margins of epipharynx without asperites near base (fig. 4). Epipharynx usually with 3 or fewer setae on each side caudolaterad of sensory area of haptomerum (fig. 4) 9

9. Postclypeus usually with 3 long setae on each side. With 20 or more setae on lateral lobe of mesothorax. With 5 or more setae on lateral lobe 2 of abdominal segment 9 (fig. 22) . . *sonorae*

Postclypeus with 2 or 3 setae on each side, if 3, then third is always much smaller than other two setae. With less than 20 setae on lateral lobe of mesothorax. Usually with 4 or fewer setae on posterior lateral lobe of abdominal segment 9.

plicatus, *robinsoni*, and *tuberculatus*

KEY TO THE KNOWN THIRD STAGE LARVAE OF *OMORGUS*

1. Dorsal lobe 1 of first 4 abdominal segments with transverse row of spinules only, very rarely with 1 long seta per segment (fig. 33) 2
   Dorsal lobe 1 of first 4 abdominal segments with at least 6 setae in addition to transverse row of spinules 3
2. Frons with posterior frontal setae (fig. 24) . . . . . *monachus*
   Frons without posterior frontal setae . . . . . *fuliginosus*
3. Cranium with large concavity on median border of eyespot. Concavity with single seta. Concavity about same size as eyespot; anterior border declivous; posterior border vertical (fig. 25) . 4
   Cranium smooth mediad of eyespot, or with at most a very shallow depression with a single seta 5
4. Galea with at least 4 setae on dorsal surface in addition to whorl of 5 setae at base of terminal uncus (fig. 49) . . . . . .*texanus*
   Galea without setae on dorsal surface, only with whorl of 5 setae at base of terminal uncus (fig. 26) . . . . . .*rubricans*
5. Epipharynx with group of phobae mediad of right fused phobal mass (fig. 11) . . . . . .*suberosus*
   Epipharynx without group of phobae mediad of right fused phobal mass (fig. 9) 6
6. Lacinia with 1 or more exterior setae (fig. 26) . . . . . .*inflatus*
   Lacinia without exterior setae 7
7. Head capsule width greater than 5.0 mm. Each tibiotarsus with average of 21 to 26 setae. Epipharynx as in figure 11 . *scutellaris*
   Head capsule width less than 4.5 mm. Each tibiotarsus with average of 15 to 21 setae . . . . *punctatus*, *asper*, and *carinatus*

Generic Description of *Trox* Larvae

Larvae of this genus may be characterized as follows: **Cranium** (fig. 1) light orange or light orange brown, red brown, or dark red brown to black. Cranium usually slightly reticulate posterior to posterior frontal setae, with prominent elevated and depressed areas anterior to posterior frontal setae. Cranium strongly pitted in *T. fascifer*, *T. aequalis*, and *T. scaber;* pits very small or lacking in other species. With 1 dorsal epicranial seta and 1 median epicranial seta on each side (median epicranial seta very short or absent in above three species). With about 5 to 12 long setae near each antenna and with small, slightly raised, nonpigmented eyespot at base of each antenna. Frons with paired posterior, median, exterior, and anterior setae. Each anterior angle of frons with 1 seta. Frontoclypeal suture indistinct,

especially in median region. **Postclypeus** as dark or darker than cranium, with 2 or 3 setae on each side. **Preclypeus** light yellow, glabrous. **Labrum** (fig. 1) symmetrical, darker than preclypeus, with paired median, lateral, anterolateral, and anterior setae. Lateral margins evenly rounded to sharply angulate; anterior margin broadly rounded to weakly bilobed or trilobed. **Antennae** (figs. 1 and 20) three-segmented, terminal segment much reduced. Segment 2 with prominent, distal sensory cone. Segment 3 with terminal sensory pegs; all groups except *terrestris* group with 5 pegs and 1 seta (figs. 45 and 46); *terrestris* group with 6 pegs (figs. 44 and 47). **Epipharynx** (figs. 2 and 3–8) with about 4 to 13 stout setae on each side of corypha. Clithra present. Corypha with 4 prominent setae arising from marginal tubercles. Haptomerum at least partially sclerotized, with central, elevated, lightly sclerotized sensory area usually with 2 (4 in *scaber* group) smaller sensory spots distad of 2 larger, setiferous sensory spots. Haptomerum also with about 1 to 6 setae posterolaterad of sensory area on each side. Setae often overlapping paria. Anterior border of pedium usually with 4 (2 in *scaber* group) sensory spots distad of slightly arching, transverse row of about 10 to 16 sensory spots. Pedium usually with curving, continuous row of inwardly directed phobae near lateral and anterior borders, anterior phobae proximad of sensory spots usually very small; or pedium with slightly oblique row of inwardly directed phobae along lateral border on each side, these rows usually joined anteriorly by transverse row of reduced phobae proximad of sensory spots. Variations of the above 2 basic patterns also occur. Pedium with additional pronounced median, transverse patch of caudally directed phobae. With a fused phobal mass on each side of pedium near posterior border. Pedium often with smaller phobae mediad or proximad of fused phobal masses, latter phobae usually more pronounced on right side when present. Paria with posterior group of about 5 to 13 stout setae on each side near tormae. Tormae symmetrical; united medially, with anterior epitorma and prominent pternotormae. Haptolachus with 2 elevated, sclerotized plates flanking median, nonpigmented, elevated area. Sclerotized plates unequal, left plate smaller. Median elevated area with numerous phobae in area between sclerotized plates; usually with 4 sensory spots posteriorly. Haptolachus also with 2 macrosensilla in membranous areas on each side of central elevated area. **Glossa** (fig. 19) with 4 sensory spots and usually 4 to 6 setae dorsally; with 2 sensory spots and 2 long setae ventrally. Labial palpi two-segmented; basal segment with terminal, exterior phobal fringe. **Hypopharynx** (fig. 19) divided into smaller distal area and larger proximal area. Distal area with 2 sensory spots distad of transverse row of about 10 to 18 sensory spots. Lateral regions of smaller distal area each with slightly oblique row of phobae. Larger proximal area with symmetrical subtormae adjoining medially and bearing paired sub-

apotormae. Central, depressed area bordered laterally and posteriorly by row of inwardly directed, closely set phobae. Distal phobae on right side usually curving slightly mediad to connect with patch of phobae near apex of right subapotorma. Hypopharynx also with prominent, elevated, sclerotized process located above point where subtormae adjoin. **Maxilla** (figs. 41 and 42) with galea and lacinia separate. Lacinia with 3 prominent unci and about 10 to 22 marginal setae. Two-segmented galea with whorl of 5 setae at base of terminal uncus. Four-segmented maxillary palpus with 1 seta on basal segment and 2 setae on segment 3. Stipes and cardo each with 1 seta on exterior surface. Maxillary stridulatory area with curved double row or curved patch of small stridulatory teeth.

Mandibles (figs. 40 and 43) darker than head capsule, with 2 widely spaced setae in dorsal exterior groove. Left mandible slightly longer. With small, sharp tooth (S_3) proximad of scissorial notch of left mandible. With larger, rounded tooth (S_2) proximad of scissorial notch of right mandible. Both mandibles with single tooth (S_4 of left mandible and S_3 of right mandible) on inner margin between scissorial and manducatorial areas. Tooth on left mandible usually larger. With small brustia near base of tooth on ventral surface of each mandible. Molar area of left mandible hollowed to receive right mandible. Each mandible with brustia on median border near base.

Prothorax (fig. 39) with prominent yellow brown to dark brown, sclerotized shield on each side; shield bordered with setae. Setae more numerous on anterior border and not continuous across dorsal nonsclerotized area between shields. With 2 lateral lobes with about 1 to 10 setae each. Biforous spiracle located caudodorsad posterior of 2 lateral lobes. Sternum with or without a few small setae.

Mesothorax (fig. 39) divided dorsally into larger anterior lobe (DL1) and smaller posterior lobe (DL2). DL1 with transverse row of about 14 to 40 setae. DL2 without setae. Lateral lobe with about 2 to 30 setae. Sternum usually with group of about 2 to 8 setae on each of 2 lobes.

Metathorax also divided dorsally into larger anterior lobe (DL1) and smaller posterior lobe (DL2). DL1 with transverse row of about 15 to 45 setae and 2 spinules. Spinules widely separated and anterior to row of setae. DL2 often with 1 or 2 spinules. With 2 lateral lobes; anterior lobe usually very small and with 0 to about 4 setae, larger posterior lobe with about 3 to 10 setae. Sternum with about 2 to 10 setae on each of 2 lobes.

Infraepisternal area usually with 1 large seta on prothorax, with or without large setae on mesothorax, usually without large setae on metathorax. Infraepimeral area usually with 2 to 10 large setae, setae usually increasing in number from prothorax to metathorax.

Legs (fig. 38) four-segmented and subequal, becoming slightly longer posteriorly. Short setae numerous on all 4 segments; long setae only on 2 basal segments. Each leg with long, terminal claw with 2 setae. Tibiotarsus with 2 whorls of 6 setae each.

Abdomen (dorsal aspect, figs. 35, 36, and 37) with segments 1 through 8 with 3 dorsal lobes (DL1, DL2, and DL3) and lateral biforous spiracles. Segments 1 through 4 with similar setal pattern. Setae usually increasing in number from segment 1 to about segment 3. With transverse row or band of only spinules on DL1 and DL3. With transverse row or band of spinules plus setae on DL2. Setae usually posterior to spinules, becoming more numerous laterally and often intergrading with setae of spiracular lobe. DL3 with 2 associated dorsolateral lobes (DL3a and DL3b) usually with a few scattered setae or spinules. Segments 5 and 6 with setal pattern similar to segments 1 to 4 with exception of DL3. DL3 with narrow, transverse patch of spinules flanked anterolaterally by small group of spinules on DL3b. DL3a usually with a few small setae. DL3a and DL3b greatly reduced on all segments posterior to segment 6. Segment 7 with transverse group of spinules or setae on DL1. DL2 with transverse row or band of setae or of intermixed setae and spinules. DL3 glabrous, with transverse row of about 1 to 15 small setae, or with isolated, small spinules. Segment 8 with transverse row of about 4 to 10 setae on DL1. DL2 with transverse row of about 6 to 20 setae. DL3 glabrous or with up to about 7 scattered, small setae. Segment 9 with 2 rows of setae; anterior row with about 4 to 8 long setae, posterior row with about 4 to 10 long and short setae. Segment 10 with 1 or 2 rows of caudally directed spiniform setae.

Abdomen (lateral aspect, fig. 35) with segments 1 through 8 with 3 setae-bearing lobes (LL1, LL2, and LL3). LL1 with about 1 to 4 setae; LL2 with about 2 to 8 setae; LL3 with 0 to about 4 setae. Setae on each respective lobe usually decreasing in number posteriorly from about segment 3 to segment 8. Segment 9 with only 2 lateral lobes. LL1 with about 1 to 3 setae; larger posterior lobe (LL2) with about 3 to 10 setae. Segment 10 usually with 2 rows of caudally directed spiniform setae; anterior row of setae usually reduced in size and number.

Abdomen (ventral aspect, similar to fig. 28) with 3 transverse lobes (VL1, VL2, and VL3). VL1 without setae. VL2 with transverse row of about 8 to 24 setae on segments 1 and 2, decreasing to about 2 to 10 setae on segment 9. VL3 constricted in median region, expanded laterally, with about 4 to 10 setae on each side on anterior segments, decreasing to about 1 to 3 setae on each side on segment 9. Number and size of setae and size of lobes on venter usually decreasing progressively from about segment 3 to segment 9. Segment 10 with 2 rows of caudally directed spiniform setae, anterior row reduced in size and

number. Both rows narrowly discontinuous in median region. Anal opening surrounded by single dorsal lobe and 2 larger ventral lobes (fig. 53).

Species Descriptions of *Trox* Larvae

Trox fascifer LeConte

Trox fascifer LeConte, 1854, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, p. 213.

Description based upon the following material. Twenty-eight larvae reared from a single female taken in a black light trap in Corvallis, Benton Co., Oreg., May 18, 1963, by Charles W. Baker.
LI: head capsule width 0.89 to 0.93 mm.; 2 specimens.
LII: head capsule width 1.20 to 1.24 mm.; 2 specimens.
LIII: head capsule width 1.64 to 1.86 mm.; 24 specimens.

Description of Third Stage Larva

FIGURES 8 AND 55

Cranium light orange to light orange brown, with numerous prominent pits. Median epicranial setae very small or absent. Exterior and anterior setae of frons very small. **Postclypeus** with 1 long and 1 short seta on each side. **Epipharynx** with about 5 to 6 marginal setae on each side of corypha. Sensory area of haptomerum with 4 smaller sensory spots distad of 2 larger setiferous sensory spots. Haptomerum also with 1 large seta on each side of sensory area, seta on right side usually only slightly removed from anterior border; distad of seta on left side. Anterior region of pedium usually with 2 sensory spots distad of transverse, slightly arching row of about 10 sensory spots. Tormae with short, stout pternotormae. **Hypopharynx** with smaller distal area with 2 sensory spots distad of transverse row of about 10 sensory spots. **Maxilla** with lacinia with 3 prominent unci and about 10 to 12 marginal setae.

Prothorax with about 2 setae on anterior lateral lobe, usually with about 4 setae on posterior lateral lobe. Infraepisternal region usually with 1 seta; infraepimeral area usually with 2 setae.

Mesothorax with about 4 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 2 setae.

Metathorax with or without single seta on anterior lateral lobe. Posterior lateral lobe with about 5 setae. Infraepisternal region usually without setae; infraepimeral area with about 2 setae.

Abdomen (dorsal aspect) with DL1 of segments 1 through 4 with single transverse row of about 14 spinules. DL3 with single row of about 4 to 8 spinules. Segment 7 with transverse row of about 12 to 14 intermixed setae and spinules on DL1. DL2 with transverse row of about 18 to 20 long and short setae. DL3 with a few scattered small setae.

Abdomen (lateral aspect) with segments 1 to 8 usually with 1 to 2 setae on LL1; LL2 usually with 2 to 4 setae; LL3 with about 1 or 2 setae.

Trox scaber (Linnaeus)

Silpha scabra Linnaeus, 1767, Systema naturae, ed. 12, p. 573.

Description based on the following material. Twenty-six larvae reared from a single female collected at black light about 10 miles north of Corvallis, Benton Co., Oreg., April 26, 1965, by Charles W. Baker. Twenty-two larvae reared from F_1 adults of the above female. Four larvae collected from palm tubs in Bremen, Germany, June–July, 1930, by J. D. Alfken. Loaned by P. O. Ritcher.
LI: head capsule width 0.80 to 0.93 mm.; 11 specimens.
LII: head capsule width 1.02 to 1.27 mm.; 17 specimens.
LIII: head capsule width 1.39 to 1.70 mm.; 24 specimens.

Description of Third Stage Larva

FIGURES 3, 23, 40, 41, 46, AND 58

Cranium light orange to light orange brown; with numerous prominent pits. Median epicranial setae very short or absent. With about 5 long setae near each antenna. Exterior and anterior setae of frons very short. **Postclypeus** usually with 1 long and 1 short seta on each side. **Epipharynx** with about 4 to 5 marginal setae on each side of corypha. Sensory area of haptomerum usually with 4 smaller sensory spots distad of 2 larger setiferous sensory spots. Haptomerum also with 1 large seta on each side of sensory area, seta on right side usually only slightly removed from anterior border of epipharynx. Anterior region of pedium usually with 2 sensory spots distad of slightly arching, transverse row of about 10 sensory spots. **Hypopharynx** with distal area with 2 sensory spots distad of transverse row of about 10 sensory spots. **Maxilla** with lacinia bearing 3 unci and about 10 to 12 stout setae.

Prothorax with about 1 or 2 setae on anterior lateral lobe, usually with 1 seta on posterior lateral lobe. Infraepisternal and infraepimeral areas usually with 1 seta each.

Mesothorax with about 3 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area usually with 1 seta.

Metathorax usually without setae on anterior lateral lobe, with about 3 to 5 setae on posterior lateral lobe. Infraepisternal area usually without setae; infraepimeral area usually with 1 seta.

Abdomen (dorsal aspect) with DL1 of segments 1 through 4 with single transverse row of about 10 to 14 spinules, DL3 with transverse row of about 4 to 8 spinules. Segment 7 with transverse row of about 10 to 12 spinules on DL1. DL2 with diffuse transverse row of spiniform setae and setae. DL3 with or without a few very small spiniform setae.

Abdomen (lateral aspect) with segments 1 to 8 usually with 1 seta on LL1; LL2 with about 3 setae; LL3 usually with 1 seta.

Trox aequalis Say

Trox aequalis Say, 1831, New species of . . . insects found . . . chiefly in Louisiana, p. 5.

Description based on the following material. Fifteen larvae with 3 associated adults collected in a buzzard's nest on Jackson's Island, Md., July 13, 1912, by Carnochan and Barber. Nineteen larvae with 1 associated adult collected in a buzzard's nest on Jackson's Island, Md., June, 1919, by Carnochan and Barber.
Loaned by U.S. National Museum.
LI: head capsule width 0.86 to 0.90 mm.; 2 specimens.
LII: head capsule width 1.17 to 1.31 mm.; 12 specimens.
LIII: head capsule width 1.64 to 1.86 mm.; 20 specimens.

Description of Third Stage Larva

FIGURES 6 AND 54

Cranium light orange to light orange brown, with numerous prominent pits. Median epicranial setae usually absent. With about 5 long setae near base of each antenna. Exterior and anterior setae on frons very short. **Postclypeus** usually with 1 long seta and 1 short seta on each side. **Epipharynx** usually with 4 marginal setae on each side of corypha. Sensory area of haptomerum usually with 4 smaller sensory spots distad of 2 larger, setiferous sensory spots. Haptomerum also usually with 1 seta on each side anterolaterad of sensory area, seta on right side being only slightly removed from anterior border of epipharynx. Anterior region of pedium usually with 2 sensory spots distad of slightly arching, transverse row of about 10 sensory spots. **Hypopharynx** with distal area with 2 sensory spots distad of transverse row of about 10 sensory spots. **Maxilla** with lacinia with 3 unci and about 10 marginal setae.

Prothorax usually with 1 seta on anterior and posterior lateral lobes. Infraepisternal and infraepimeral areas usually with 1 seta each.

Mesothorax with about 3 or 4 setae on lateral lobe. Infraepisternal area usually without long setae; infraepimeral area usually with 1 seta.

Metathorax with or without 1 seta on anterior lateral lobe and about 2 or 3 setae on posterior lateral lobe. Infraepisternal area usually without long setae; infraepimeral area usually with 1 or 2 setae.

Abdomen (dorsal aspect) with DL1 of segments 1 to 4 with transverse row of about 8 to 12 spinules, DL3 with transverse row of about 2 to 6 spinules. Segment 7 with transverse row of about 6 to 10 spiniform setae on DL1, DL2 with transverse row of short and long setae. DL3 with or without a few very small setae.

Abdomen (lateral aspect) with segments 1 to 8 usually with 1 seta on LL1; LL2 usually with 2 setae; LL3 usually with 1 seta.

Trox atrox LeConte

Trox atrox LeConte, 1854, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, p. 214.

Description based on the following material. Thirty larvae reared from 6 adults collected at black light about 2.5 miles east of Hermiston, Umatilla Co., Oreg., June 11–13, 1963, by Charles W. Baker. Ten larvae reared from 4 adults collected under chicken remains and a dead crow about 5.0 miles west of Tularosa, Otero Co., N. Mex., July 22, 1964, by David R. Smith and Charles W. Baker. Seven larvae reared from 1 adult collected under chicken remains about 4.0 miles north of Las Cruces, Dona Ana Co., N. Mex., July 22, 1964, by David R. Smith and Charles W. Baker.

LI: head capsule width 1.05 to 1.15 mm.; 9 specimens.
LII: head capsule width 1.39 to 1.58 mm.; 6 specimens.
LIII: head capsule width 1.98 to 2.39 mm.; 32 specimens.

Description of Third Stage Larva

FIGURES 23 AND 38

Cranium yellow orange to light yellow brown, with about 10 to 14 setae near each antenna. **Postclypeus** with 3 setae on each side. **Epipharynx** with about 8 to 10 marginal setae on each side of corypha. Sensory area of haptomerum usually with 4 smaller sensory spots distad of 2 larger setiferous sensory spots. Haptomerum also with 1 seta on left side anterolaterad of sensory area. Anterior region of pedium with 2 sensory spots distad of slightly arching transverse row of about 12 to 14 sensory spots. Tormae with short, stout pternotormae. **Hypopharynx** with smaller distal area with 2 sensory spots distad of transverse row of about 12 sensory spots. **Maxilla** with lacinia with 3 unci and about 12 to 15 stout marginal setae.

Prothorax with about 4 setae on anterior lateral lobe and about 8 setae on posterior lateral lobe. Infraepisternal area usually with 1 seta; infraepimeral area with about 3 setae.

Mesothorax with about 10 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 8 setae.

Metathorax with about 2 setae on anterior lateral lobe, with about 10 setae on posterior lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 8 setae.

Abdomen (dorsal aspect) with DL1 of segments 1 through 4 with transverse band of about 25 to 40 spinules. DL3 with transverse row of about 8 to 14 spinules. Segment 7 with transverse group of about 30 short setae plus scattered spinules on DL1. DL2 with transverse band of setae. DL3 with scattered setae.

Abdomen (lateral aspect) with segments 1 to 8 with about 2 to 3 setae on LL1; LL2 with about 4 to 8 setae; LL3 with about 2 to 4 setae.

Trox spinulosus dentibius Robinson

Trox (*Trox*) *dentibius* Robinson, 1940, Trans. Amer. Ent. Soc., vol. 66, p. 156, pl. 4, figs. 4, 14.

Trox spinulosus dentibius Robinson, Vaurie, 1955, Bull. Amer. Mus. Nat. Hist., vol. 106, p. 38, figs. 6, 25I.

Description based on the following material. Twenty-eight larvae reared from adults collected at black light at the Southwest Research Station, Cochise Co., Ariz., July 4–8, 1963, by Noel McFarland. Six larvae reared from adults collected under a coyote carcass about 3.0 miles east of La Luz, Otero Co., N. Mex., July 22, 1964, by David R. Smith and Charles W. Baker.

LI: head capsule width 0.99 to 1.03 mm.; 3 specimens.

LII: head capsule width 1.27 to 1.40 mm.; 10 specimens.

LIII: head capsule width 1.55 to 1.86 mm.; 21 specimens.

Description of Third Stage Larva

FIGURES 5 AND 47

Cranium orange brown to light red brown, with about 6 long setae near each antenna. Anterior setae of frons reduced. **Postclypeus** with 2 or 3 setae on each side, if 3, then third is very short. **Epipharynx** with about 5 marginal setae on each side of corypha. Sensory area of haptomerum with 2 smaller sensory spots distad of 2 larger, setiferous sensory spots. Haptomerum also usually with 2 setae on each side caudolaterad of sensory area. Anterior region of pedium usually with 4 sensory spots distad of slightly arching transverse row of about 10 sensory spots. **Hypopharynx** with smaller distal area with 2 sensory

spots distad of transverse row of about 10 sensory spots. **Maxilla** with lacinia with 3 unci and about 12 stout marginal setae.

Prothorax usually with 1 seta on anterior lateral lobe and 1 or 2 setae on posterior lateral lobe. Infraepisternal area usually with 1 seta; infraepimeral area usually with 1 or 2 setae.

Mesothorax with about 4 to 6 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area usually with 2 setae.

Metathorax usually without setae on anterior lateral lobe, with about 4 to 5 setae on posterior lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 2 to 3 setae.

Abdomen (dorsal aspect) with DL1 of segments 1 through 4 with single transverse row of about 14 to 20 spinules, DL3 with single transverse row of about 4 to 10 spinules. Segment 7 with transverse row of about 10 to 14 spinules on DL1. DL2 with scattered spinules intermixed in transverse row of setae. DL3 with scattered setae.

Abdomen (lateral aspect) with segments 1 through 8 usually with 1 seta on LL1; LL2 usually with 3 setae; LL3 usually with 2 setae.

Trox foveicollis Harold

Trox foveicollis Harold, 1872, Coleopterologische Hefte, vol. 9, page 181.

Description based on the following material. Thirty-six larvae reared from adults collected under chicken remains about 4 miles north of Bronson, Sabine Co., Tex., July 7, 1964, by David R. Smith and Charles W. Baker.

LI: head capsule width 0.93 to 0.96 mm.; 9 specimens.

LII: head capsule width 1.20 to 1.30 mm.; 7 specimens.

LIII: head capsule width 1.61 to 1.74 mm.; 20 specimens.

Description of Third Stage Larva

FIGURE 36

Cranium orange brown to light red brown, with about 6 long setae near each antenna. Anterior setae of frons somewhat shorter. **Postclypeus** usually with 2 setae on each side. **Epipharynx** with about 5 to 6 marginal setae on each side of corypha. Sensory area of haptomerum with 2 smaller sensory spots distad of 2 larger setiferous sensory spots. Haptomerum also usually with 2 setae caudolaterad of sensory area. Anterior region of pedium usually with group of 4 sensory spots distad of slightly arching transverse row of about 10 sensory spots. **Hypopharynx** with smaller distal area usually with 2 sensory spots distad of transverse row of about 10 sensory spots. **Maxilla** with lacinia with 3 unci and about 10 to 11 stout marginal setae.

Prothorax usually with 1 or 2 setae on anterior and posterior lateral lobes. Infraepisternal and infraepimeral areas usually with 1 seta each.

Mesothorax with about 3 to 6 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area usually with 2 setae.

Metathorax usually without setae on anterior lateral lobe, with about 4 to 6 setae on posterior lateral lobe. Infraepisternal area usually without setae; infraepimeral area usually with 2 setae.

Abdomen (dorsal aspect) with DL1 of segments 1 through 4 with single transverse row of about 12 to 18 spinules, DL3 with transverse row of about 6 to 10 spinules. Segment 7 with transverse row of about 10 to 16 spinules on DL1. DL2 usually with 2 spinules intermixed in transverse row of setae. DL3 with or without a few scattered, small setae.

Abdomen (lateral aspect) with segments 1 to 8 usually with 1 seta on LL1; LL2 usually with 2 or 3 setae; LL3 usually with 1 or 2 setae.

Trox frontera Vaurie

Trox frontera Vaurie, 1955, Bull. Amer. Mus. Nat. Hist., vol. 106, p. 41, figs. 9, 10, 25M.

Description based on the following material. Thirty-eight larvae reared from 64 adults collected in soil under what was probably a very old sheep or goat carcass about 0.5 miles east of Hebbronville, Jim Hogg Co., Tex., July 14–15, 1964, by David R. Smith and Charles W. Baker.

LI: head capsule width 1.11 to 1.21 mm.; 7 specimens.
LII: head capsule width 1.48 to 1.62 mm.; 13 specimens.
LIII: head capsule width 1.95 to 2.21 mm.; 18 specimens.

Description of Third Stage Larva

FIGURES 16, 17, 18, AND 44

Cranium light orange to light yellow brown, with about 6 to 9 setae near each antenna. **Postclypeus** with 3 setae on each side. **Epipharynx** with about 7 to 10 marginal setae on each side of corypha. Sensory area of haptomerum usually with 2 smaller sensory spots distad of 2 larger, setiferous sensory spots. Haptomerum usually also with 2 setae on each side caudolaterad of sensory area. Anterior region of pedium usually with 4 sensory spots distad of slightly arching row of about 10 to 12 sensory spots. **Hypopharynx** with smaller distal area with 2 sensory spots distad of transverse row of about 11 to 13 sensory spots. **Maxilla** with lacinia with 3 unci and about 12 to 15 stout marginal setae.

Prothorax usually with 2 setae on anterior lateral lobe and about 8 setae on posterior lateral lobe. Infraepisternal area usually with 1 seta; infraepimeral area with about 4 setae.

Mesothorax with about 11 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 6 setae.

Metathorax with about 2 setae on anterior lateral lobe and about 11 setae on posterior lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 6 setae.

Abdomen (dorsal aspect) with DL1 of segments 1 through 4 with transverse band of about 24 to 28 spinules, DL3 with single transverse row of about 11 to 19 spinules. Segment 7 with transverse band of about 6 to 12 spinules and about 17 small setae on DL1. DL2 with transverse row of numerous setae. DL3 with transverse row of about 10 to 14 small setae.

Abdomen (lateral aspect) with segments 1 to 8 usually with 1 to 2 setae on LL1; LL2 with about 3 to 7 setae; LL3 with about 2 to 4 setae.

Trox robinsoni Vaurie

Trox robinsoni Vaurie, 1955, Bull. Amer. Mus. Nat. Hist., vol. 106, p. 47, figs. 12, 13, 25P.

Description based on the following material. Twenty-nine larvae reared from adults collected under a bird carcass near Kerrville, Kerr Co., Tex., September 12–13, 1964, by Larry J. Bottimer.
LI: head capsule width 1.45 to 1.55 mm.; 5 specimens.
LII: head capsule width 1.86 to 2.00 mm.; 7 specimens.
LIII: head capsule width 2.35 to 2.64 mm.; 16 specimens.

Description of Third Stage Larva

FIGURE 39

Cranium deep red brown to brown, with about 4 to 8 long setae near each antenna. **Postclypeus** usually with 2 or 3 setae on each side, if 3, then third is very short. **Epipharynx** with about 7 to 9 stout marginal setae on each side of corypha. Sensory area of haptomerum usually with 2 smaller sensory spots distad of 2 larger, setiferous sensory spots. Haptomerum also with 2 setae on each side caudolaterad of sensory area. Anterior region of pedium usually with 4 sensory spots distad of slightly arching transverse row of about 12 to 14 sensory spots. **Hypopharynx** with smaller distal area usually with 2 sensory spots distad of transverse row of about 12 sensory spots. **Maxilla** with lacinia with 3 unci and about 14 to 18 stout marginal setae.

Prothorax usually with about 1 to 2 setae on anterior lateral lobe and usually with 1 seta on posterior lateral lobe. Infraepisternal and infraepimeral areas usually with 1 long seta each.

Mesothorax with about 13 to 17 setae on lateral lobe. Infraepisternal area with 0 to about 3 very small setae; infraepimeral area with about 3 to 5 long setae.

Metathorax usually without setae on anterior lateral lobe, sometimes with 1 seta. With about 5 to 7 setae on posterior lateral lobe. Infraepisternal area with about 1 to 3 very small setae, infraepimeral area with about 2 to 4 long setae.

Abdomen (dorsal aspect) with DL1 of segments 1 through 4 with transverse band of about 20 to 31 spinules, DL3 with transverse row of about 6 to 12 spinules. Segment 7 with transverse band of about 24 to 32 spinules on DL1. DL2 with about 4 to 5 scattered, small spinules plus row of setae. DL3 with about 2 to 5 small setae.

Abdomen (lateral aspect) with segments 1 to 8 usually with 1 seta on LL1; with 2 to 5 setae on LL2; with 1 to 2 setae on LL3.

Trox plicatus Robinson

Trox (*Trox*) *plicatus* Robinson, 1940, Trans. Amer. Ent. Soc., vol. 66, p. 153, pl. 4, fig. 10.

Description based on the following material. Forty-seven larvae reared from adults collected at lights at the Southwest Research Station, Cochise Co., Ariz., July 4–8, 1963, by Noel McFarland. Ten larvae collected under a fawn carcass about 3.0 miles northwest of McDonald Observatory, Jeff Davis Co., Tex., June 27, 1964, by David R. Smith and Charles W. Baker.

LI: head capsule width 1.27 to 1.40 mm.; 22 specimens.
LII: head capsule width 1.73 to 1.93 mm.; 11 specimens.
LIII: head capsule width 2.26 to 2.60 mm.; 24 specimens.

Description of Third Stage Larva

Cranium red brown to dark brown, with about 6 to 8 long setae near each antenna. **Postclypeus** with 2 or 3 setae on each side, if 3, then third very small. **Epipharynx** with about 6 to 8 stout marginal setae on each side of corypha. Sensory area of haptomerum usually with 2 smaller sensory spots distad of 2 larger, setiferous sensory spots. Haptomerum also usually with 2 setae on each side caudolaterad of sensory area. Anterior region of pedium usually with 4 sensory spots distad of slightly arching transverse row of about 12 to 14 sensory spots. **Hypopharynx** with smaller distal area usually with 2 sensory spots distad of transverse row of about 12 sensory spots. **Maxilla** with lacinia with 3 unci and about 14 to 16 marginal setae.

Prothorax with about 1 to 3 setae on anterior lateral lobe and about 1 to 2 setae on posterior lateral lobe. Infraepisternal area usually with 1 seta; infraepimeral area usually with 2 setae.

Mesothorax with about 10 to 13 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 3 to 5 setae.

Metathorax usually with 0 or 1 seta on anterior lateral lobe and about 7 to 11 setae on posterior lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 2 to 6 setae.

Abdomen (dorsal aspect) with DL1 of segments 1 through 4 with transverse band of about 21 to 34 spinules; DL3 with transverse row of about 6 to 11 spinules. Segment 7 with transverse band of about 25 to 29 spinules or spinules and spiniform setae on DL1. DL2 with about 2 to 4 small spinules plus transverse row of setae. DL3 with transverse row of about 5 to 15 small setae.

Abdomen (lateral aspect) with segments 1 to 8 usually with 1 to 3 setae on LL1; LL2 with about 2 to 5 setae; LL3 with about 1 to 3 setae.

Trox tuberculatus (De Geer)

Scarabaeus tuberculatus De Geer, 1774, Memoires pour servir a l'histoire des insectes, vol. 4, p. 318, pl. 19, fig. 2.

Trox tuberculatus (De Geer) Vaurie, 1955, Bull. Amer. Mus. Nat. Hist., vol. 106, p. 51.

Description based on the following material. Twenty larvae reared from an aggregation of 18 adults collected as follows: 14 adults collected under a crow carcass and a cow carcass at the Boyce Thompson Institute Forest Research Laboratory, Hardin Co., Tex., July 3–5, 1964, by Robert I. Gara, David R. Smith, and Charles W. Baker; 4 adults collected under chicken remains in a dumpsite about 4.0 miles north of Bronson, Sabine Co., Tex., July 7, 1964, by David R. Smith and Charles W. Baker.

LI: head capsule width 1.45 to 1.58 mm.; 3 specimens.
LII: head capsule width 1.82 to 1.98 mm.; 4 specimens.
LIII: head capsule width 2.44 to 2.63 mm.; 13 specimens.

Description of Third Stage Larva

FIGURES 15 AND 37

Cranium red brown to dark red brown, with about 5 or 6 setae near each antenna. **Postclypeus** usually with 2 setae on each side, if 3, then third is very short. **Epipharynx** with about 7 to 9 setae on each side of corypha. Sensory area of haptomerum usually with 2 smaller sensory spots distad of 2 larger, setiferous sensory spots. Haptomerum also usually with 3 to 4 setae on each side caudolaterad of sensory area. Anterior region of pedium generally with 4 sensory spots distad of slightly arching, transverse row of about 12 to 14 sensory spots. **Hypopharynx** with smaller distal area usually with 2 sensory spots distad

of transverse row of about 10 to 12 sensory spots. **Maxilla** with lacinia with 3 unci and about 16 to 18 stout marginal setae.

Prothorax usually with 1 or 2 setae on anterior and posterior lateral lobes, with 1 seta on infraepisternal and infraepimeral areas.

Mesothorax with about 11 to 12 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 3 setae.

Metathorax usually with 0 to 1 seta on anterior lateral lobe and about 5 to 6 setae on posterior lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 3 setae.

Abdomen (dorsal aspect) with DL1 of segments 1 through 4 with transverse band of about 24 to 32 spinules. DL3 with transverse row of about 9 to 16 spinules. Segment 7 with transverse band of about 26 to 40 spinules on DL1. DL2 with about 6 to 12 scattered spinules plus transverse row of setae. DL3 with about 2 to 5 scattered, small setae.

Abdomen (lateral aspect) with segments 1 to 8 usually with about 1 to 2 setae on LL1; with about 3 to 6 setae on LL2; with about 1 to 2 setae on LL3.

Trox sonorae LeConte

Trox sonorae LeConte, 1854, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, p. 211.

Description based on the following material. Forty-eight larvae reared from an aggregation of 40 adults collected as follows: 5 at a cow carcass about 18 miles south of Rodeo, Hildago Co., N. Mex., July 18, 1964, by Martin A. Mortenson and Mont A. Cazier; 6 at the same cow carcass July 25, 1964, by David R. Smith and Charles W. Baker; 29 at a cow carcass about 6 miles east of Portal, Cochise Co., Ariz., July 24–25, 1964, by David R. Smith and Charles W. Baker. Two larvae reared from 12 adults collected at a sheep carcass about 6 miles southeast of Sheffield, Pecos Co., Tex., July 17, 1964, by David R. Smith and Charles W. Baker.

LI: head capsule width 1.55 to 1.65 mm.; 10 specimens.
LII: head capsule width 2.01 to 2.21 mm.; 12 specimens.
LIII: head capsule width 2.48 to 3.05 mm.; 28 specimens.

Description of Third Stage Larva

FIGURES 4, 20, 22, 23, 31, 35, 43, 45, 52, 53, AND 56

Cranium dark brown to black, with about 8 to 12 long setae near each antenna. **Postclypeus** with 3 long setae on each side. **Epipharynx** with about 10 to 13 stout marginal setae on each side. Sensory area of haptomerum usually with 2 smaller sensory spots distad of 2 larger, setiferous sensory spots. Haptomerum also usually with 3 setae on each side caudolaterad of sensory area. Anterior region of pedium usually with 4 sensory spots distad of slightly arching transverse row of about

14 to 16 sensory spots. **Hypopharynx** with smaller distal area usually with 2 sensory spots distad of transverse row of about 12 to 14 sensory spots. **Maxilla** with lacinia with 3 unci and about 17 to 22 marginal setae.

Prothorax with about 1 to 3 setae on anterior lateral lobe and about 2 to 4 setae on posterior lateral lobe. Infraepisternal area usually with 1 seta; infraepimeral area usually with 2 setae.

Mesothorax with about 25 to 30 setae on lateral lobe. Infraepisternal area with about 2 to 4 small setae; infraepimeral area with about 5 to 7 long setae.

Metathorax usually with 2 to 4 setae on anterior lateral lobe and about 5 to 10 setae on posterior lateral lobe. Infraepisternal area usually with about 2 to 4 small setae; infraepimeral area with about 6 to 8 long setae.

Abdomen (dorsal aspect) with DL1 of segments 1 through 4 with transverse band of about 25 to 50 spinules. DL3 with transverse row of about 6 to 17 spinules. Segment 7 with transverse band of about 34 to 43 spinules on DL1. DL2 with about 2 to 7 small spinules plus transverse row of setae. DL3 with about 2 to 7 scattered, small setae.

Abdomen (lateral aspect) with segments 1 to 8 usually with about 1 to 3 setae on LL1; with about 3 to 7 setae on LL2; with about 1 to 3 setae on LL3.

Trox variolatus Melsheimer

Trox variolatus Melsheimer, 1846, Proc. Acad. Nat. Sci. Philadelphia, vol. 2, p. 138.

Description based on the following material. Twenty-one larvae reared from adults collected under a mohair bait near Kerrville, Kerr Co., Tex., September 29 to October 1, 1964, by Larry J. Bottimer.
LI: head capsule width 1.36 to 1.43 mm.; 4 specimens.
LII: head capsule width 1.73 to 1.83 mm.; 4 specimens.
LIII: head capsule width 1.98 to 2.30 mm.; 13 specimens.

Description of Third Stage Larva

FIGURE 2

Cranium yellow brown to brown; with about 5 to 7 long setae near each antenna. **Postclypeus** with 1 long and 1 short seta on each side. **Epipharynx** with about 6 stout marginal setae on each side of corypha. **Haptomerum** with 2 smaller sensory spots distad of 2 larger, setiferous sensory spots. Haptomerum also with 2 setae on each side caudolaterad of sensory area; anterior setae smaller and closer together. Anterior region of pedium usually with 4 smaller sensory spots distad of arching

row of about 12 sensory spots. Tormae with prominent anterior epitorma and pointed pternotormae. **Hypopharynx** with smaller distal area usually with 2 sensory spots distad of transverse row of about 12 sensory spots. **Maxilla** with lacinia with 3 unci and about 12 to 15 marginal setae.

Prothorax usually with 1 seta on anterior and posterior lateral lobes. Infraepisternal area usually with 1 seta; infraepimeral area usually with 2 setae.

Mesothorax with about 3 to 6 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area usually with 2 setae.

Metathorax usually without setae on anterior lateral lobe, with about 4 to 5 long setae on posterior lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 1 to 2 setae.

Abdomen (dorsal aspect) with DL1 of segments 1 to 4 with single transverse row of about 14 to 20 spinules, DL3 with transverse row of about 4 to 10 spinules. Segment 7 with transverse row of about 10 to 16 spinules, often with few intermixed setae. DL2 with transverse row of long and short setae. DL3 often with 1 or 2 small setae.

Abdomen (lateral aspect) with segments 1 to 8 usually with 1 seta LL1; LL2 with about 2 or 3 setae; LL3 usually with 1 seta.

Trox sordidus LeConte

Trox sordidus LeConte, 1854, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, p. 211.

Description based on the following material. Sixteen larvae reared from 21 adults collected at chicken remains about 4 miles north of Bronson, Sabine Co., Tex., July 7, 1964, by David R. Smith and Charles W. Baker. Three larvae collected in soil under same chicken remains by David R. Smith and Charles W. Baker.
LI: head capsule width 1.39 to 1.46 mm.; 5 specimens.
LII: head capsule width 1.67 to 1.83 mm.; 5 specimens.
LIII: head capsule width 2.04 to 2.30 mm.; 9 specimens.

Description of Third Stage Larva

FIGURE 19

Cranium deep red brown, with about 6 long setae near each antenna. Anterior setae of frons very short. **Postclypeus** with 2 setae on each side. **Epipharynx** with about 6 or 7 stout marginal setae on each side of corypha. **Haptomerum** with 2 smaller sensory spots distad of 2 larger, setiferous sensory spots on sensory area. Haptomerum also with about 2 to 4 widely separated, stout setae on each side caudolaterad of sensory area. Anterior region of pedium usually with group of 4 smaller sensory spots distad of slightly arching, transverse row of

about 12 to 13 larger sensory spots. Tormae with broad anterior epitorma and prominent pternotormae.

Hypopharynx with smaller distal area with 2 sensory spots distad of transverse row of about 12 to 16 sensory spots. **Maxilla** with lacinia with 3 unci and about 14 to 15 marginal setae.

Prothorax usually with 1 seta on anterior and posterior lateral lobes. Infraepisternal and infraepimeral areas usually with 1 seta each.

Mesothorax with about 3 to 4 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area usually with 2 setae.

Metathorax usually without setae on anterior lateral lobe, with about 3 to 4 long setae on posterior lateral lobe. Infraepisternal area usually without setae; infraepimeral area usually with 2 setae.

Abdomen (dorsal aspect) with segments 1 through 4 with transverse, irregular row or double row of about 20 to 28 spinules. DL3 with transverse row of about 4 to 10 spinules. Segment 7 with transverse band of about 20 to 32 spinules. DL2 with about 6 to 10 scattered spinules plus row of setae. LL3 with about 2 to 4 reduced spinules.

Abdomen (lateral aspect) with segments 1 to 8 usually with 1 seta on LL1; LL2 usually with 2 setae; LL3 usually with 1 seta on anterior segments, without setae on LL3 of segments 7 and 8.

Trox unistriatus Beauvois

Trox unistriatus Beauvois, 1805, Insectes receuilles . . . en Amerique, p. 175, pl. 4b, fig. 5.

Description based on the following material. Fourteen larvae collected in soil beneath feathers at Raleigh, Wake Co., N. Car., October 29, 1951, by Henry F. Howden and Paul O. Ritcher.
LIII: head capsule width 2.79 to 3.08 mm.; 14 specimens.

Description of Third Stage Larva

FIGURES 1, 7, AND 42

Cranium dark orange red to black, with about 6 long setae near each antenna. Anterior setae of frons very short. **Postclypeus** with 2 long setae on each side. **Epipharynx** with about 5 to 8 stout marginal setae on each side of corypha. **Haptomerum** largely sclerotized, with 2 to 7 setae on each side of sensory area. Sensory area usually with 2 smaller sensory spots distad of 2 larger setiferous sensory spots. **Hypopharynx** with smaller distal area bearing 2 larger sensory spots distad of irregular, transverse row of about 16 to 18 smaller sensory spots.

Prothorax usually with 1 or 2 setae on anterior lateral lobe and about 1 to 3 setae on posterior lateral lobe. Infraepisternal area and infraepimeral area usually with 1 or 2 setae.

Mesothorax with about 5 to 7 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 3 to 4 setae.

Metathorax usually with 1 to 3 setae on anterior lateral lobe and about 4 to 6 setae on posterior lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 2 to 4 setae.

Abdomen (dorsal aspect) with DL1 of segments 1 through 4 with transverse band of about 22 to 36 spinules; DL3 with transverse row of about 5 to 14 spinules. Segment 7 with transverse row of about 24 to 36 spinules on DL1; DL2 with transverse row of about 4 to 10 spinules plus setae; DL3 usually with about 4 to 10 reduced spinules or setae.

Abdomen (lateral aspect) with segments 1 to 8 usually with 1 to 4 setae on LL1; LL2 usually with 2 to 5 setae; LL3 usually with 1 to 4 setae.

Generic Description of *Omorgus* Larvae

Larvae of this genus may be characterized as follows: **Cranium** (figs. 24 and 25) red brown or brown to black, reticulate posterior to posterior frontal setae, slightly rugose anterior to posterior frontal setae. Oval, slightly raised, nonpigmented eyespot near base of each antenna. One (rarely 2) dorsal epicranial seta on each side and 10 or more setae near each antenna. Frons with paired posterior (lacking in *O. fuliginosus*), median, exterior, and anterior setae. Each anterior angle with about 4 to 15 setae; setae usually arranged in 2 groups. Frontoclypeal suture distinct. **Postclypeus** as dark as or darker than cranium, with 3 (rarely 4) long setae on each side. **Preclypeus** light yellow brown, glabrous. **Labrum** (fig. 57) symmetrical, darker than preclypeus, distal margin bilobed. With paired median, lateral, anterolateral, and anterior setae. **Antennae** (figs. 21 and 25) three-segmented, terminal segment much reduced. Segment 2 with distal, slightly depressed, crescent-shaped sensory area. Segment 3 with terminal group of 6 small sensory pegs. **Epipharynx** (figs. 9 and 11) with about 20 or more stout setae along anterior border on each side of corypha. Clithra present. Corypha with 4 prominent setae arising from pronounced marginal tubercles. Haptomerum at least partially sclerotized, with central, elevated, lightly sclerotized sensory area usually with 2 (rarely 3) smaller sensory spots slightly distad of 2 larger, setiferous sensory spots. Sensory area usually flanked by or contiguous with smaller, lightly sclerotized area on each side. Each smaller area with single seta. Sclerotized portion of haptomeral region usually giving rise posteriorly to slightly curving, sclerotized band on each side of pedium. Sclerotized band less prominent anteriorly in some species, becoming more prominent posteriorly and terminating at fused phobal mass on

each side. Anterior region of pedium usually with 4 sensory spots distad of slightly arching, transverse row of about 12 to 20 sensory spots; the 4 sensory spots widely separated, as 2 groups of 2 each, or intermixed with main transverse row of sensory spots. Pedium with numerous phobae except in anterior median region and in posterior area between fused phobal masses. Pedium with fused phobal mass on each side near posterior border. Paria with anterior and posterior group of setae on each side. Posterior setae much stouter. Anterior setae tending to intergrade with marginal setae and posterior setae, especially on right side of epipharynx. Setae usually more numerous on right side. Tormae symmetrical, united medially, with prominent pternotorma on each side. Haptolachus with 2 sclerotized, elevated plates and median sense cone. Sclerotized plates unequal; left plate smaller. Sense cone with 4 sensory spots in central hyaline region. Sense cone also with small to large group of pigmented phobae at anterior end in some species. Central hyaline region of sense cone occasionally traversed by longitudinal bar. Paired macrosensillae located laterad of sense cone in membranous area on each side. **Glossa** (figs. 10 and 12) with 4 sensory spots and about 10 to 30 setae dorsally. Labial palpi two-segmented; basal segment with distal fringe of phobae on lateral aspect. **Hypopharynx** (figs. 10 and 12) divided into smaller distal area and larger proximal area. Distal area with 2 larger sensory spots distad of transverse row of about 14 to 23 smaller sensory spots with minute setae. Lateral areas each with slightly oblique row of densely set phobae extending to base of labial palpi. Larger proximal area with symmetrical subtormae adjoining medially and bearing paired subapotormae. Right subapotorma with prominent, dense group of phobae at apex (absent in *O. rubricans*). Proximal area also with row of inwardly directed, closely set phobae laterad of each subapotorma, row extending length of proximal area. With prominent, elevated, sclerotized process located anterior to point where subtormae adjoin. **Maxilla** (fig. 49) with galea and lacinia separate. Lacinia with 3 prominent unci, numerous stout setae along median border, and 1 to several finer setae bordering stout setae on dorsal surface. Two-segmented galea with whorl of 5 setae at base of terminal uncus; with 1 seta at base of galea on ventral aspect. Four-segmented maxillary palpus with 1 seta on basal segment and 2 setae on segment 3. Stipes with 1 to 12 setae on exterior surface. Maxillary stridulatory area with longitudinal, straight row of about 20 to 60 stridulatory teeth. **Mandibles** (fig. 48) darker than head capsule; with 2 well separated setae in dorsal exterior groove. Left mandible slightly longer. With small, sharp tooth (S_3) proximad of scissorial notch of left mandible. With larger, rounded tooth (S_2) proximad of scissorial notch of right mandible. Both mandibles with prominent tooth (S_3 of right mandible and S_4 of left mandible) on inner margin between scissorial and manducatorial areas. Addi-

tional smaller tooth (S_4 of right mandible and S_5 of left mandible) on ventral aspect of each mandible at base of S_3 and S_4. Smaller teeth each with small brustia near base. Molar area of left mandible hollowed for reception of molar area of right mandible. Each mandible with brustia on median border near base.

Prothorax (fig. 29) with prominent yellow brown to black, sclerotized shield on each side; shield bordered with setae. Setae more numerous on anterior border. Setae continuous across dorsal nonsclerotized area between shields. Large lateral lobe with about 25 to 100 setae. Cribriform spiracle located caudodorsad of lateral lobe; concavity of respiratory plate directed anteroventrally. Sternum with 0 to about 20 setae on each of 2 weak, transverse lobes.

Mesothorax (fig. 29) divided dorsally into larger anterior lobe and smaller posterior lobe. Anterior lobe with transverse band of numerous setae; posterior lobe with transverse row of about 8 to 18 setae. Large lateral lobe with about 20 to 85 setae. Sternum with 2 groups of setae, with about 6 to 50 setae in each group.

Metathorax (fig. 29) also divided dorsally into larger anterior lobe and smaller posterior lobe. Anterior lobe with transverse band of numerous setae; posterior lobe with transverse row of about 8 to 18 spinules and about 4 to 12 setae. With 2 lateral lobes; smaller anterior lobe with about 5 to 25 setae and larger posterior lobe with about 17 to 60 setae. Sternum with 2 groups of setae; anterior transverse band with about 7 to 60 setae; posterior patch with about 7 to 50 setae.

Infraepisternal area usually with 1 to 10 setae on prothorax; with or without as many as 8 setae on mesothorax and metathorax. Infraepimeral area of prothorax with about 2 to 20 setae; with about 8 to 40 setae on both mesothorax and metathorax.

Legs (fig. 27) four-segmented and subequal, increasing slightly in length posteriorly. Short setae numerous on all four segments; long setae only on 2 basal segments. Each leg with long terminal claw with 2 setae. Tibiotarsus with terminal whorl of 6 setae plus about 15 to 22 setae proximad of whorl.

Abdomen (dorsal aspect, fig. 33) with segments 1 through 8 with 3 dorsal lobes (DL1, DL2, and DL3) and lateral cribriform spiracles. Spiracles subequal, with concavity of respiratory plate directed anteroventrally. Segments 1 through 6 with similar setal pattern. DL1 with transverse row of spinules usually flanked anteriorly and posteriorly by short, fine setae (absent in at least 2 species). DL2 with transverse row of spinules plus setae. Long and short setae occur posterior to spinules but only short setae occur anterior to spinules, setae becoming more numerous laterally and often intergrading with setae of spiracular lobe. DL3 with row of spinules plus setae. Long setae occur posterior to spinules on segments 1 to 4 and anterior to spinules on segments 5 and 6. When present, short setae occur anterior to spinules on

segments 1 to 4 and posterior to spinules on segments 5 and 6. DL3 also with 3 associated dorsal-lateral lobes (DL3a, DL3b, and DL3c, fig. 33). DL3a and DL3c with few setae; DL3b with few setae plus spinules, spinules more numerous on segments 4 to 6. DL3c partially coalesced with DL3 in segment 5. DL3a, DL3b, and DL3c at least partially coalesced with DL3 in segment 6; greatly reduced or lacking posterior to segment 6. Segment 7 with transverse row of about 4 to 20 spinules plus setae on DL1. Setae absent in some species. DL2 and DL3 of segment 7 with transverse band of setae. Segment 8 with transverse row of setae on DL1. DL2 and DL3 with transverse band of numerous setae. Segment 9 with 2 transverse rows of setae; setae more numerous in posterior row. Segment 10 without subdivisions, with broad band of caudally directed, spiniform setae; longer anterior and posterior setae organized into rather discrete rows.

Abdomen (lateral aspect, fig. 33) with 3 distinct setae-bearing lobes (LL1, LL2, and LL3) on segments 1 through 8. Setae on each respective lobe usually decreasing in number posteriorly from about segment 3 to segment 8. Segment 9 normally with only 2 lateral lobes. Segment 10 with band of numerous spiniform setae; band slightly depressed on anterior border opposite LL2 of segment 9.

Abdomen (ventral aspect, figs. 28 and 33) with 3 distinct setae-bearing lobes (VL1, VL2, and VL3) on segments 1 through 8. VL1 with or without fine setae on segments 1 through 5; without setae on segments 6 through 9. VL3 constricted in median region, expanded laterally, with group of setae on each side. Each group of setae usually separated into subgroups by weakly impressed, longitudinal fold. Number and size of setae and size of lobes on ventral aspect usually decreasing progressively from about segment 3 to segment 9. Segment 9 usually with about one-half as many setae as found on anterior segments. Segment 10 with broad band of caudally directed, spiniform setae; band narrowly discontinuous at median line. Anal opening surrounded by single dorsal lobe and 2 larger ventral lobes (fig. 51).

Species Descriptions of *Omorgus* Larvae

Omorgus suberosus (Fabricius)

Trox suberosus Fabricius, 1775, Systema entomologiae, p. 31.

Description based on the following material. Eight larvae reared from 4 adults taken at black light about 2.5 miles east of Hermiston, Umatilla Co., Oreg., June 11–13, 1963, by Charles W. Baker. Ten larvae reared from 3 adults collected at black light about 1.0 mile south of Hermiston, Umatilla Co., Oreg., June 18, 1963, by William

P. Stephen and Charles E. Osgood. Three larvae reared from single adult collected at a dried coyote carcass about 2.0 miles east of Rodeo, Hildago Co., N. Mex., August 7, 1963, by Noel McFarland and Chris Schuberth.
LI: head capsule width 2.11 to 2.15 mm.; 2 specimens.
LII: head capsule width 2.85 to 2.90 mm.; 2 specimens.
LIII: head capsule width 3.60 to 4.48 mm.; 17 specimens.

Description of Third Stage Larva

FIGURE 11

Cranium light red brown to dark red brown, with about 12 to 18 setae near each antenna. Each anterior angle of frons with about 5 to 8 setae. **Epipharynx** with about 20 stout setae near anterior border on each side of corypha. With group of phobae mediad of fused phobal mass on right side. Paria with about 8 to 14 posterior setae and about 15 to 22 anterior setae on each side. **Glossa** with 4 sensory spots and about 14 to 16 setae dorsally; with 2 sensory spots and 2 long setae ventrally. **Maxilla** with stipes bearing 1 to 3 setae on exterior surface. Maxillary stridulatory area with longitudinal row of about 16 to 22 stridulatory teeth.

Prothorax with about 40 to 50 setae on lateral lobe. Infraepisternal area with about 1 to 4 setae; infraepimeral area with about 7 to 17 setae.

Mesothorax with about 30 to 50 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 15 to 23 setae.

Metathorax with transverse row of about 14 to 18 spinules and 4 to 7 setae on smaller dorsal lobe (DL2). Anterior lateral lobe (LL1) with about 9 to 13 setae. Posterior lateral lobe (LL2) with about 25 to 60 setae. Infraepisternal area usually with 1 to 3 setae; infraepimeral area with about 19 to 22 setae.

Legs with each tibiotarsus with terminal whorl of 6 setae plus about 9 to 11 setae proximad of whorl.

Abdomen with transverse row of about 10 to 16 spinules plus setae on DL1 of segment 7.

Omorgus fuliginosus (Robinson)

Trox (*Omorgus*) *fuliginosus* Robinson, 1941, Ent. News, vol. 52, p. 134.

Description based on the following material. Twenty-one larvae reared from 1 female and 5 males collected under 2 deer carcasses 1.0 mile south of Uvalde, Uvalde Co., Tex., June 29, 1964, by David R. Smith and Charles W. Baker.

285-935—68——4

LI: head capsule width 2.64 to 2.85 mm.; 4 specimens.
LII: head capsule width 3.52 mm.; 2 specimens.
LIII: head capsule width 4.04 to 4.83 mm.; 15 specimens.

Description of Third Stage Larva

FIGURES 29 AND 57

Cranium dull red brown, with about 11 to 18 setae near each antenna. Frons without posterior frontal setae. Each anterior angle of frons with about 3 to 7 setae. **Epipharynx** with about 16 to 22 stout setae near anterior border on each side of corypha. Paria with about 19 to 32 anterior setae and about 7 to 11 stouter posterior setae on each side. **Glossa** with 4 sensory spots and about 13 to 17 setae dorsally; with 2 sensory spots and 2 long setae ventrally. **Maxilla** with stipes bearing 1 to 3 setae on exterior surface. Maxillary stridulatory area with longitudinal row of about 15 to 20 stridulatory teeth.

Prothorax with about 30 to 45 setae on lateral lobe. With 1 seta on infraepisternal area; infraepimeral area with about 6 to 10 setae.

Mesothorax with about 22 to 30 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 10 to 14 setae.

Metathorax with transverse row of about 12 spinules and 4 setae on smaller dorsal lobe (DL2). Anterior lateral lobe (LL1) with about 7 to 11 setae. Posterior lateral lobe (LL2) with about 21 to 25 setae. Infraepisternal area usually without setae; infraepimeral area with about 10 to 14 setae.

Legs with each tibiotarsus with terminal whorl of 6 setae plus about 14 to 18 setae proximad of whorl.

Abdomen with transverse row of spinules on DL1 of segments 1 through 6. Segment 7 with transverse row of spinules posterior to row of sparse setae on DL1.

Omorgus monachus (Herbst)

Trox monachus herbst, 1790, Natursystem aller bekannten inund auslandischen Insekten, vol. 3, p. 25, pl. 21, fig. 7.

Description based on the following material. Thirteen larvae reared from 2 adults collected under an old crow carcass at the Boyce Thompson Institute Forest Research Laboratory, Hardin Co., Tex., May 12, 1964, by Robert I. Gara. Eight larvae collected beneath a pile of chicken feathers 4.0 miles north of Bronson, Sabine Co., Tex., July 7, 1964, by David R. Smith and Charles W. Baker.

LI: head capsule width 2.46 to 2.55 mm.; 5 specimens.
LII: head capsule width 3.43 mm.; 1 specimen.
LIII: head capsule width 4.04 to 4.75 mm.; 15 specimens.

Description of Third Stage Larva

FIGURES 13, 14, 23, 24, 30, 32, 33, 34, AND 59

Cranium dark red brown, with about 12 to 16 setae near each antenna. Each anterior angle of frons with about 4 to 6 setae. **Epipharynx** with about 20 stout setae near anterior border on each side of corypha. Paria with about 12 to 24 anterior setae and about 7 to 14 stouter posterior setae on each side. **Glossa** with 4 sensory spots and about 14 to 20 setae dorsally; with 2 sensory spots and 2 long setae ventrally. **Maxilla** with stipes bearing 1 to 3 setae on exterior surface. Maxillary stridulatory area with longitudinal row of about 14 to 26 stridulatory teeth.

Prothorax with about 25 to 32 setae on lateral lobe. Infraepisternal area usually with 1 seta; infraepimeral area with about 5 to 7 setae.

Mesothorax with about 20 to 30 setae on lateral lobe. Infraepisternal area usually lacking setae; infraepimeral area with about 8 to 12 setae.

Metathorax with transverse row of about 14 to 18 spinules and setae on smaller dorsal lobe (DL2). Anterior lateral lobe (LL1) with about 5 to 10 setae. Posterior lateral lobe (LL2) with about 17 to 22 setae. Infraepisternal area usually without setae; infraepimeral area with about 10 to 12 setae.

Legs with each tibiotarsus with terminal whorl of 6 setae plus about 11 to 15 setae proximad of whorl.

Abdomen with transverse row of spinules on DL1 of segments 1 through 6. Segment 7 with transverse row of about 14 to 18 intermixed spinules and setae on DL1.

Omorgus asper LeConte

Omorgus asper LeConte, 1854, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, p. 215.

Description based on the following material. Twenty-two larvae reared from 4 adults collected under an old crow carcass at the Boyce Thompson Institute Forest Research Laboratory, Hardin Co., Tex., May 12, 1964, by Robert I. Gara.
LI: head capsule width 2.10 to 2.30 mm.; 8 specimens.
LII: head capsule width 2.81 to 3.30 mm.; 5 specimens.
LIII: head capsule width 3.60 to 4.04 mm.; 9 specimens.

Description of Third Stage Larva

FIGURE 21

Cranium dark brown to black, with about 13 to 18 setae near each antenna. Each anterior angle of frons with about 7 to 10 setae. **Epipharynx** with about 17 to 21 stout setae near anterior border on each side of corypha. Paria with about 10 to 25 anterior setae and about 6 to 13 stouter posterior setae on each side. **Glossa** with 4 sensory spots and about 12 to 16 setae dorsally; with 2 sensory spots and 2 long setae ventrally. **Maxilla** with stipes bearing 1 to 3 setae on exterior surface. Maxillary stridulatory area with longitudinal row of about 20 to 30 stridulatory teeth.

Prothorax with about 35 to 50 setae on lateral lobe. Infraepisternal area with about 2 to 5 setae; infraepimeral area with about 8 to 13 setae.

Mesothorax with about 30 to 45 setae on lateral lobe. Infraepisternal area usually without setae; infraepimeral area with about 18 to 24 setae.

Metathorax with transverse row of about 7 to 14 spinules and 3 to 7 setae on smaller dorsal lobe (DL2). Anterior lateral lobe (LL1) with about 8 to 14 setae. Posterior lateral lobe (LL2) with about 30 to 36 setae. Infraepisternal area with 0 to about 6 setae; infraepimeral area with about 18 to 20 setae.

Legs with each tibiotarsus with terminal whorl of 6 setae plus about 8 to 12 setae proximad of whorl.

Abdomen with transverse row of about 5 to 10 spinules and about 20 to 30 setae on DL1 of segment 7.

Omorgus inflatus (Loomis)

Trox inflatus Loomis, 1922, Journ. Washington Acad. Sci., vol. 12, p. 135, fig. 1.

Description based on the following material. Five larvae reared from 1 female collected at a dried coyote carcass about 2.0 miles east of Rodeo, Hildago Co., N. Mex., August 7, 1963, by Noel McFarland and Chris Schuberth. Three larvae reared from 1 female collected under a coyote carcass about 3.0 miles east of La Luz, Otero Co., N. Mex., July 22, 1964, by David R. Smith and Charles W. Baker.
LI: head capsule width 2.20 mm.; 1 specimen.
LIII: head capsule width 3.96 to 4.48 mm.; 7 specimens.

Description of Third Stage Larva

FIGURE 26

Cranium dark red brown, with about 16 to 24 setae near each antenna. Each anterior angle of frons with about 7 to 11 setae. **Epipharynx** with about 18 to 25 stout setae near anterior border on each side of corypha. Paria with about 10 to 25 anterior setae and about 7 to 12 stouter posterior setae on each side. **Glossa** with 4 sensory spots and about 18 to 20 setae dorsally; with 2 sensory spots and 2 long setae ventrally. **Maxilla** with stipes bearing 1 to 4 setae on exterior surface. Maxillary stridulatory area with longitudinal row of about 20 to 30 stridulatory teeth. Lacinia with 1 or 2 exterior setae.

Prothorax with about 65 to 80 setae on lateral lobe. Infraepisternal area with about 6 to 10 setae; infraepimeral area with about 15 to 20 setae.

Mesothorax with about 50 to 85 setae on lateral lobe. Infraepisternal area usually with 1 to 4 setae; infraepimeral area with about 28 to 40 setae.

Metathorax with transverse row of about 9 to 15 spinules and 8 to 12 setae on smaller dorsal lobe (DL2). Anterior lateral lobe (LL1) with about 20 to 30 setae. Posterior lateral lobe (LL2) with about 55 to 75 setae. Infraepisternal area with about 4 to 7 setae; infraepimeral area with about 30 to 44 setae.

Legs with each tibiotarsus with terminal whorl of 6 setae plus about 12 to 16 setae proximad of whorl.

Abdomen with transverse row of about 13 to 20 spinules and 20 to 35 setae on DL1 of segment 7.

Omorgus punctatus (Germar)

Trox punctatus Germar, 1824, Insectorum species novae, vol. 1, p. 113.

Description based on the following material. Six larvae reared from 2 females collected at cow carcasses within 10 miles of Rodeo, Hildago Co., N. Mex., July 24–26, 1964, by David R. Smith and Charles W. Baker.

LIII: head capsule width 3.69 to 4.04 mm.; 6 specimens.

Description of Third Stage Larva

FIGURE 27

Cranium dark red brown to black, with about 15 to 20 setae near each antenna. Each anterior angle of frons with about 7 to 9 setae.

Epipharynx with about 18 to 24 setae near anterior border on each side of corypha. Paria with about 15 to 25 anterior setae and about 10 to 15 stouter posterior setae on each side. **Glossa** with 4 sensory spots and about 12 to 16 setae dorsally; with 2 sensory spots and 2 long setae ventrally. **Maxilla** with stipes bearing about 1 to 4 setae on exterior surface. Maxillary stridulatory area with longitudinal row of about 15 to 30 stridulatory teeth.

Prothorax with about 45 to 60 setae on lateral lobe. Infraepisternal area with about 3 to 5 setae; infraepimeral area with about 14 to 18 setae.

Mesothorax with about 35 to 50 setae on lateral lobe. Infraepisternal area with 0 to about 2 setae; infraepimeral area with about 24 to 32 setae.

Metathorax with transverse row of about 10 to 15 spinules and about 4 to 8 setae on smaller dorsal lobe (DL2). Anterior lateral lobe (LL1) with about 10 to 14 setae; posterior lateral lobe (LL2) with about 25 to 40 setae. Infraepisternal area with 0 to about 2 setae; infraepimeral area with 20 to 25 setae.

Legs with each tibiotarsus with terminal whorl of 6 setae plus about 12 to 15 setae proximad of whorl.

Abdomen with transverse row of about 15 to 20 spinules and about 16 to 30 setae on DL1 of segment 7.

Omorgus carinatus (Loomis)

Trox carinatus Loomis, 1922, Journ. Washington Acad. Sci., vol. 12, p. 135, fig. 1.

Description based on the following material. Twenty-three larvae reared from 6 adults collected at a dried coyote carcass about 2.0 miles east of Rodeo, Hildago Co., N. Mex., August 7, 1963, by Noel McFarland and Chris Schuberth.

LI: head capsule width 2.20 to 2.28 mm.; 3 specimens.

LII: head capsule width 2.99 to 3.08 mm.; 4 specimens.

LIII: head capsule width 3.78 to 4.22 mm.; 16 specimens.

Description of Third Stage Larva

FIGURES 12 AND 28

Cranium dark red brown to black, with about 14 to 23 setae near each antenna. Each anterior angle of frons with about 6 to 9 setae. **Epipharynx** with about 20 stout marginal setae near anterior border on each side of corypha. Paria with about 12 to 25 anterior setae and about 9 to 14 stouter posterior setae on each side. Median sense cone of haptolachus with small group of phobae at anterior end. **Glossa**

with 4 sensory spots and about 14 to 18 setae dorsally; with 2 sensory spots and 2 long setae ventrally. **Maxilla** with stipes bearing 1 to 3 setae on exterior surface. Maxillary stridulatory area with longitudinal row of about 20 to 30 teeth.

Prothorax with about 50 to 65 setae on lateral lobe. Infraepisternal area with about 1 to 5 setae; infraepimeral area with about 8 to 12 setae.

Mesothorax with about 30 to 50 setae on lateral lobe. Infraepisternal area with 0 to 2 setae; infraepimeral area with about 15 to 21 setae.

Metathorax with transverse row of about 10 to 14 spinules and 4 to 6 setae on smaller dorsal lobe (DL2). Anterior lateral lobe (LL1) with about 10 to 20 setae. Posterior lateral lobe (LL2) with about 30 to 45 setae. Infraepisternal area with 0 to 3 setae; infraepimeral area with about 13 to 20 setae.

Legs with each tibiotarsus with terminal whorl of 6 setae plus about 10 to 13 setae proximad of whorl.

Abdomen with transverse row of about 8 to 12 spinules and about 25 to 40 setae on DL1 of segment 7.

Omorgus scutellaris (Say)

Trox scutellaris Say, 1823, Journ. Acad. Nat. Sci. Philadelphia, vol. 3, p. 238.

Description based on the following material. Eight larvae reared from 1 female collected in soil under a rabbit carcass 1 mile west of Valentine, Jeff Davis Co., Tex., June 26, 1964, by David R. Smith and Charles W. Baker. One larva reared from 1 female collected under a buzzard carcass 1 mile west of Valentine, Jeff Davis Co., Tex., June 26, 1964, by David R. Smith and Charles W. Baker. Three larvae reared from an aggregation of adults collected by David R. Smith and Charles W. Baker as follows: at a cow carcass about 18 miles south of Rodeo, Hildago Co., N. Mex., July 25, 1964; at a buzzard carcass about 5.0 miles north of Rodeo, Hildago Co., N. Mex., July 24, 1964; at a cow carcass about 6.0 miles east of Portal, Cochise Co., Ariz., July 25, 1964.

LII: head capsule width 4.23 to 4.41 mm.; 2 specimens.

LIII: head capsule width 5.04 to 5.85 mm.; 10 specimens.

Description of Third Stage Larva

FIGURES 9, 48, 50, AND 51

Cranium dark red brown to black, with 1 or 2 dorsal epicranial setae on each side and about 18 to 28 setae near each antenna. Each anterior angle of frons with about 8 to 10 setae. **Postclypeus** with

3 or 4 setae on each side. **Epipharynx** with more than 20 stout setae near anterior border on each side of corypha. Sensory area of haptomerum often partially or entirely divided by sclerotized area into 2 areas with 2 sensory spots each. Paria with about 30 to 60 anterior setae and about 10 to 14 stouter posterior setae on each side. Sense cone of haptolachus with small clump of phobae at anterior end. **Glossa** with 4 sensory spots and about 15 to 21 setae dorsally; with 2 sensory spots and 2 long setae ventrally. **Maxilla** with stipes bearing 3 to 8 setae on exterior surface. Maxillary stridulatory area with longitudinal row of about 35 to 45 stridulatory teeth.

Prothorax with about 60 to 80 setae on lateral lobe. Infraepisternal area with about 3 to 5 setae; infraepimeral area with about 15 to 20 setae.

Mesothorax with about 50 to 65 setae on lateral lobe. Infraepisternal area with 1 or 2 setae; infraepimeral area with about 22 to 30 setae.

Metathorax with transverse row of about 9 to 17 spinules and 4 to 8 setae on smaller dorsal lobe (DL2). Anterior lateral lobe (LL1) with about 14 to 21 setae. Posterior lateral lobe (LL2) with about 40 to 45 setae. Infraepisternal area usually without setae; infraepimeral area with about 20 to 30 setae.

Legs with each tibiotarsus with terminal whorl of 6 setae plus about 15 to 22 setae proximad of whorl.

Abdomen with transverse band of about 8 to 14 spinules and about 45 to 60 setae on DL1 of segment 7.

Omorgus rubricans (Robinson)

Trox (*Omorgus*) *rubricans* Robinson, 1946, Trans. Amer. Ent. Soc., vol. 72, p. 57.

Description based on the following material. Eighteen larvae reared from 13 adults collected under a fawn carcass on the Rob and Bessie Welder Wildlife Foundation, San Patricio Co., Tex., July 10, 1964, by Charles W. Baker and David R. Smith.
LI: head capsule width 2.72 mm.; 1 specimen.
LII: head capsule width 3.25 to 3.60 mm.; 2 specimens.
LIII: head capsule width 4.04 to 4.65 mm.; 15 specimens.

Description of Third Stage Larva

FIGURE 10

Cranium dark brown, with about 15 to 20 setae near each antenna. With pronounced concavity mediad of eyespot. Concavity about same size as eyespot, with single seta. Anterior border of concavity declivous;

posterior border vertical. Each anterior angle of frons with about 5 to 8 setae. **Epipharynx** with about 18 to 24 setae near anterior border on each side of corypha. Sclerotization of haptomeral region most pronounced just anterior to sensory spots of pedium in form of prominent transverse band. Sclerotized band on each side of pedium reduced in anterior region, becoming more pronounced posteriorly. Usually with a few small phobae posterior to each fused phobal mass. Paria with about 18 to 30 anterior setae and about 6 to 10 stouter posterior setae on each side. Sense cone of haptolachus with central hyaline region often traversed by median longitudinal, darkened area. **Glossa** with 4 sensory spots and about 8 to 12 setae dorsally; with 2 sensory spots and 2 long setae ventrally. **Hypopharynx** with transverse band of caudally directed phobae at base of smaller distal area; without phobal patch at end of right subapotorma. **Maxilla** with stipes bearing 1 to 4 setae on exterior surface. Maxillary stridulatory area with longitudinal row of about 18 to 30 stridulatory teeth.

Prothorax with about 45 to 60 setae on lateral lobe. Infraepisternal area with about 2 setae; infraepimeral area with about 10 to 15 setae.

Mesothorax with about 36 to 50 setae on lateral lobe. Infraepisternal area usually devoid of setae; infraepimeral area with about 20 to 25 setae.

Metathorax with transverse row of about 8 to 10 spinules and 4 to 6 setae on smaller dorsal lobe (DL2). Anterior lateral lobe (LL1) with about 12 to 15 setae. Posterior lateral lobe (LL2) with about 30 to 38 setae. Infraepisternal area with 1 to 2 setae; infraepimeral area with about 20 to 24 setae.

Legs with each tibiotarsus with terminal whorl of 6 setae plus about 14 to 18 setae proximad of whorl.

Abdomen with transverse row of about 22 to 26 setae and 5 to 7 spinules on DL1 of segment 7.

Omorgus texanus LeConte

Omorgus texanus LeConte, 1854, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, p. 214.

Description based on following material. Sixteen larvae reared from adults collected at cow and javelina carcasses, and single larvae collected under a sheep carcass and a javelina carcass about 0.5 mile east of Hebbronville, Jim Hogg Co., Tex., July 13–15, 1964, by David R. Smith and Charles W. Baker.

LI: head capsule width 4.50 mm.; 2 specimens.

LII: head capsule width 4.95 to 5.40 mm.; 3 specimens.

LIII: head capsule width 5.85 to 6.93 mm.; 13 specimens.

Description of Third Stage Larva

FIGURES 23, 25, AND 49

Cranium fuscous to black, with about 30 to 40 setae near each antenna. Pronounced concavity mediad of eyespot. Concavity about same size as eyespot, with single seta. Anterior border of concavity declivous; posterior border vertical. Each anterior angle of frons with about 10 to 15 setae. **Epipharynx** with about 30 to 40 long setae near anterior border on each side of corypha. Right side of haptomerum often more heavily sclerotized. Usually with small group of phobae on each side mediad of fused phobal mass and distad of torma; group on right usually more pronounced. Paria usually with more than 60 setae on each side. Setae not readily separated into anterior and posterior groups. Sense cone of haptolachus with group of pigmented phobae at anterior end. **Glossa** with 4 sensory spots and about 24 to 30 setae dorsally, dorsal setae intergrading with ventral setae. **Hypopharynx** with smaller distal area bearing group of caudally directed phobae at base between lateral, oblique rows of phobae. **Maxilla** with galea bearing 5 to 8 fine setae on dorsal aspect in addition to whorl of 5 setae at base of terminal uncus. Stipes with about 8 to 11 setae on exterior border. Maxillary stridulatory area with about 33 to 60 stridulatory teeth.

Prothorax with about 80 to 100 setae on lateral lobe. Infraepisternal area with about 1 to 4 setae; infraepimeral area with about 10 to 14 setae.

Mesothorax with about 55 to 75 setae on lateral lobe. Infraepisternal area with 0 to 2 setae; infraepimeral area with about 31 setae.

Metathorax with transverse row of about 7 setae and 7 spinules on smaller dorsal lobe (DL2). Anterior lateral lobe (LL1) with about 20 to 25 setae. Posterior lateral lobe (LL2) with about 40 to 70 setae. Infraepisternal area usually without setae; infraepimeral area with about 35 setae.

Legs with each tibiotarsus with an average of about 23 setae in addition to terminal whorl of 6 setae.

Abdomen with about 4 small spinules and numerous short and long setae on DL1 of segment 7.

Summary

1. The adults of 12 species of *Trox* and of 10 species of *Omorgus* were collected from the spring of 1963, through the spring of 1965, and the larvae reared in the laboratory.

2. Collections of adult *Glaresis* were made in Oregon, but all attempts to rear larvae in the laboratory failed.

3. A mixture of cow hair, deer hair, sheep's wool, rabbit hair and skin, and pheasant, quail, and dove feathers and skin was found sufficient for rearing the 22 species.

4. The *suberosus* group, one of five groups of species within the genus *Trox* in North America as recognized by Vaurie (1955), is given generic status. The other four groups, *scaber*, *terrestris*, *tuberculatus*, and *unistriatus*, are retained in the genus *Trox*.

5. Seventeen morphological differences were found for separating the genera *Trox* and *Omorgus*.

6. Generic descriptions for the third stage larvae of *Trox* and *Omorgus* are presented.

7. Third stage larvae of 14 species of *Trox* are described; 10 of them for the first time.

8. Third stage larvae of 10 species of *Omorgus* are described; 8 of them for the first time.

9. Keys for separating the third stage larvae of *Trox* from those of *Omorgus* and for separating the third stage larvae of each genus are presented. Larvae of several closely related species were inseparable and are brought out in the same couplet.

10. The general biology of the adults and larvae is described on the basis of laboratory studies and field notes.

11. The life history of *T. scaber* (L.) is described as it occurred in the laboratory, and notes on several other species are given.

12. Third stage larvae of the *scaber* group and the *terrestris* group were found to possess group specific characteristics.

13. The *unistriatus* and *tuberculatus* groups could not be separated by larval characters.

14. Based on larval morphology there are species groups within the genus *Omorgus*.

15. The pertinent morphological structures are illustrated in 59 figures.

16. The lobes of the thorax and abdomen are named according to a new, simplified system, and the terms subtorma, subapotorma, and fused phobal mass are coined to facilitate the description of the epipharynx and hypopharynx.

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APPENDIX

Symbols Used on Figures

A . . . . Antenna
AA . . . Seta of anterior frontal angle
AFS . . Anterior frontal seta
AN . . . Anus
AS . . . Anterolateral seta of labrum
ASL . . Anterior seta of labrum
ASP . . Asperites
BR . . . Brustia
C . . . . Claw
CL . . . Clithrum
CON . . Concavity
COX . . Coxa
DAL . . Dorsal anal lobe
DES. . . Dorsal epicranial seta
DH . . . Distal area of hypopharynx
DL1 . . Dorsal lobe one
DL2 . . Dorsal lobe two
DL3 . . Dorsal lobe three
DL3a . . Dorsal lobe three-a
DL3b . . Dorsal lobe three-b
DL3c . . Dorsal lobe three-c
DX . . . Dexiotorma
E . . . . Eyespot
EFS . . Exterior frontal seta
ES . . . Exterior seta of lacinia
ET . . . Epitorma
F . . . . Frons
FCS . . Frontoclypeal suture
FE . . . Femur
FP . . . Fused phobal mass
G . . . . Galea
GL . . . Glossa
IM . . . Infraepimeral area
IS . . . Infraepisternal area
L . . . . Labrum
LA . . . Lacinia
LL1 . . Lateral lobe one
LL2 . . Lateral lobe two
LL3 . . Lateral lobe three
LP . . . Labial palpus
LSL . . Lateral seta of labrum
LT . . . Laeotorma
MES . . Median epicranial seta
MFS . . Median frontal seta
MP . . . Maxillary palpus
MS . . . Macrosensillum
MSL . . Median seta of labrum
P . . . . Phobae

285-935—68——5

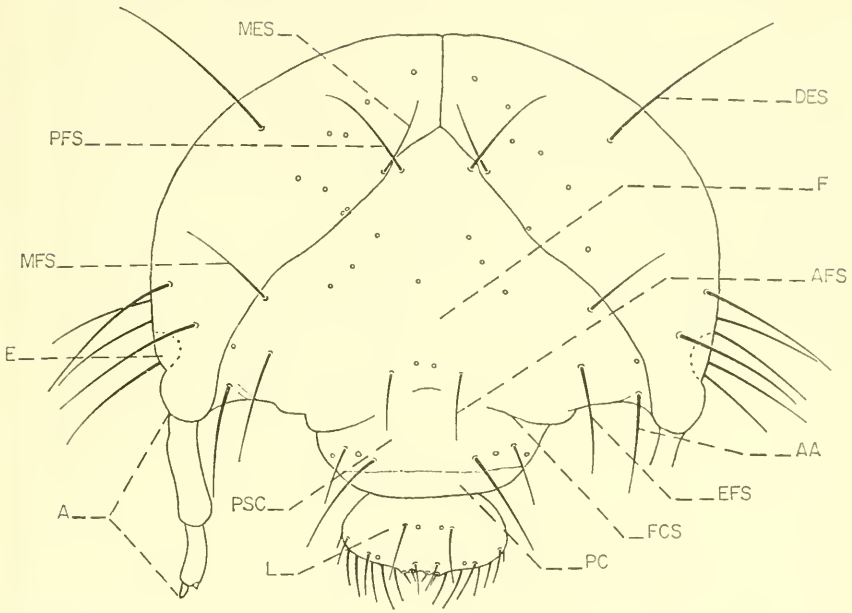
PC . . . Preclypeus
PE . . . Pedium
PFS . . . Posterior frontal setae
PH . . . Proximal area of hypopharynx
PSC . . Postclypeus
PT . . . Pternotorma
S . . . . Sensory spots
S_1-S_5 . . Teeth of mandibles
SA . . . Sensory area of haptomerum
SAT . . Subapotorma
SC . . . Sense cone
SD . . . Maxillary stridulatory area
SL . . . Spiracular lobe
SN . . . Scissorial notch
SP . . . Sensory pegs
SPH . . Sclerotized plate on haptolachus
SR . . . Spiracle
SS . . . Sensory seta
ST . . . Subtorma
TR . . . Trochanter
TT . . . Tibiotarsus
UN . . . Uncus
VAL . . Ventral anal lobe
VL1 . . Ventral lobe one
VL2 . . Ventral lobe two
VL3 . . Ventral lobe three

Illustrations

Figures 1–2

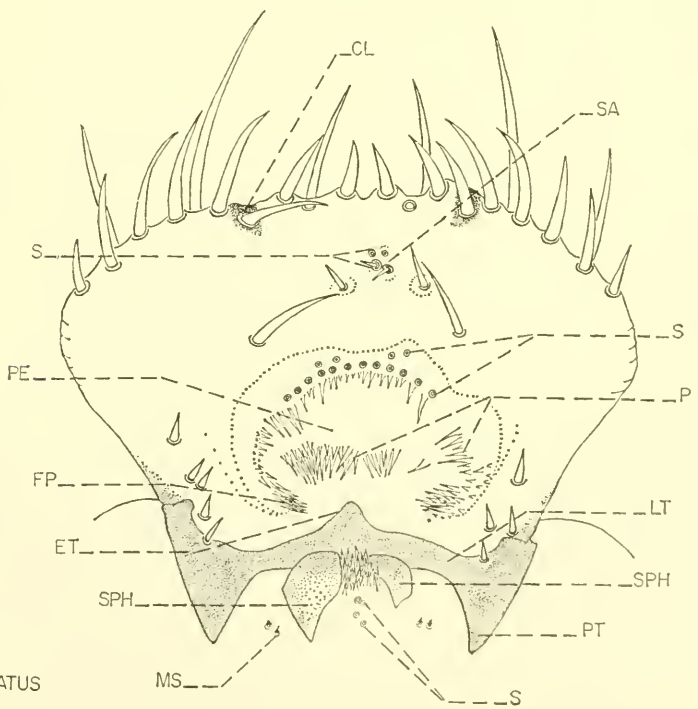
1. *Trox unistriatus* Beauvois. Head.

2. *Trox variolatus* Melsheimer. Epipharynx.



1

T. UNISTRIATUS



2

T. VARIOLATUS

Figures 3–8

3. *Trox scaber* (Linnaeus). Epipharynx.

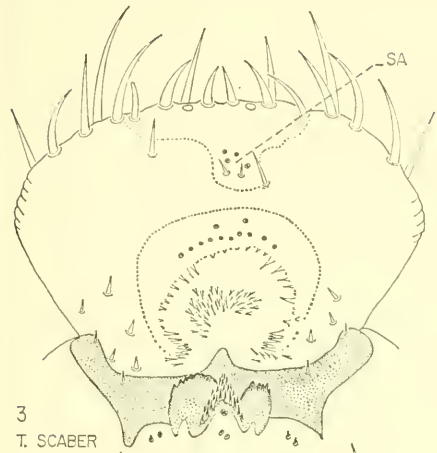
4. *Trox sonorae* LeConte. Epipharynx.

5. *Trox spinulosus dentibius* Robinson. Epipharynx.

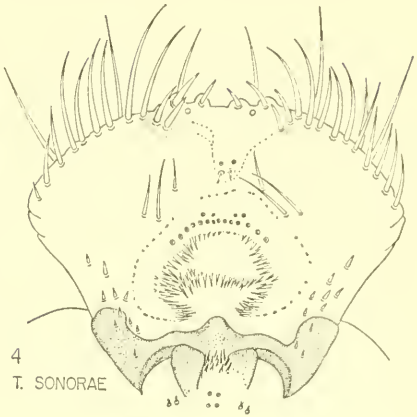
6. *Trox aequalis* Say. Epipharynx.

7. *Trox unistriatus* Beauvois. Epipharynx.

8. *Trox fascifer* LeConte. Epipharynx.



3
T. SCABER



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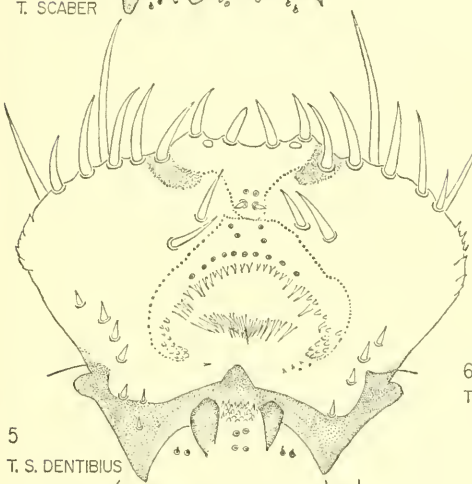
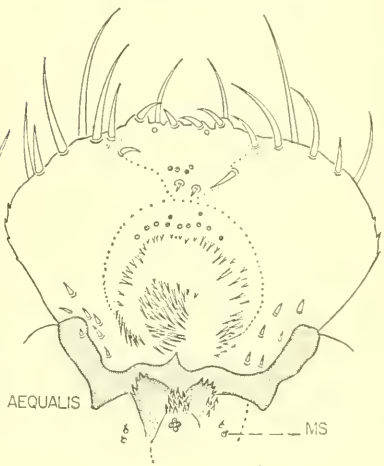
T. SONORAE



5
T. S. DENTIBIUS



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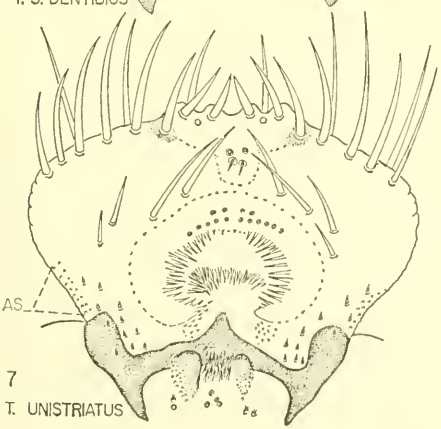
T. AEQUALIS



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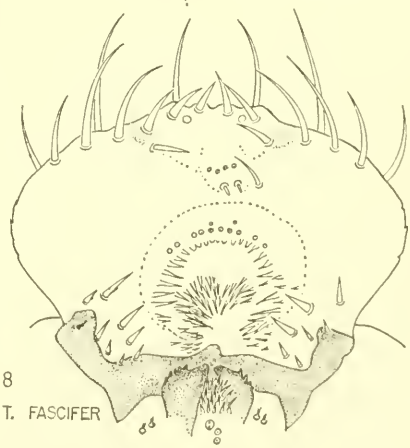


8
T. FASCIFER

Figures 9–15

9. *Omorgus scutellaris* (Say). Epipharynx.

10. *Omorgus rubricans* (Robinson). Dorsal aspect of labium and hypopharynx.

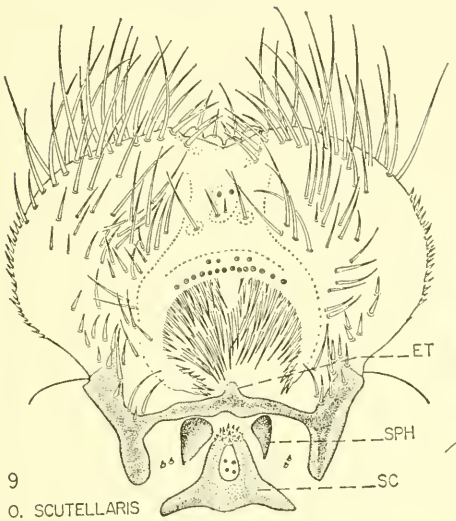
11. *Omorgus suberosus* (Fabricius). Epipharynx.

12. *Omorgus carinatus* (Loomis). Dorsal aspect of labium and hypopharynx.

13. *Omorgus monachus* (Herbst). Ventral aspect of abdominal segment 8 of female pupa.

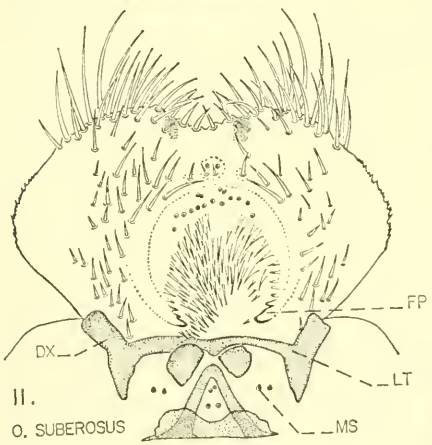
14. *Omorgus monachus* (Herbst). Ventral aspect of abdominal segment 8 of male pupa.

15. *Trox tuberculatus* (De Geer). Egg bursters from dorsum of mesothorax and metathorax.

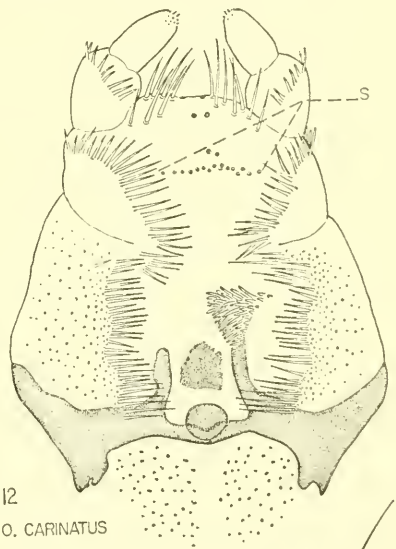


9
O. SCUTELLARIS

10
O. RUBRICANS



11.
O. SUBEROSUS



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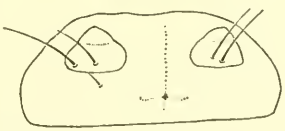
O. CARINATUS



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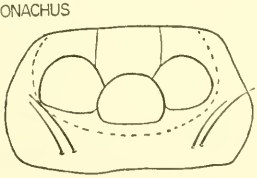
O. MONACHUS



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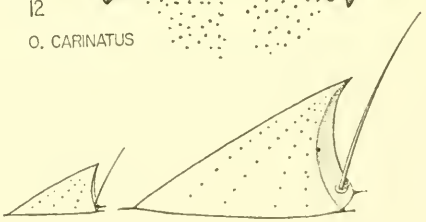
O. MONACHUS



15
T. TUBERCULATUS

Figures 16–22

16. *Trox frontera* Vaurie. First stage larva.

17. *Trox frontera* Vaurie. Second stage larva.

18. *Trox frontera* Vaurie. Third stage larva.

19. *Trox sordidus* LeConte. Dorsal aspect of labium and hypopharynx.

20. *Trox sonorae* LeConte. Second and third segments of antenna.

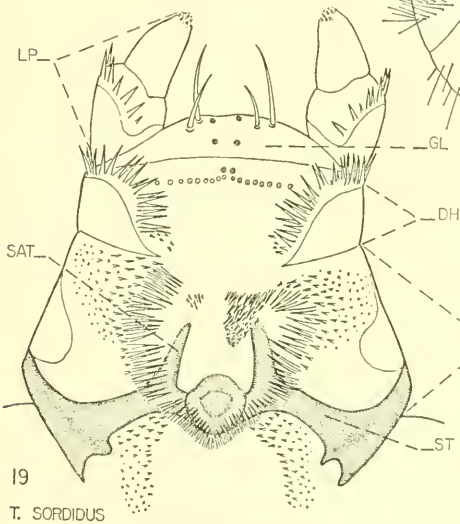
21. *Omorgus asper* LeConte. Second and third segments of antenna.

22. *Trox sonorae* LeConte. Lateral aspect of segments 7, 8, 9, and 10 of abdomen.

16
T. FRONTERA

17
T. FRONTERA

18
T. FRONTERA



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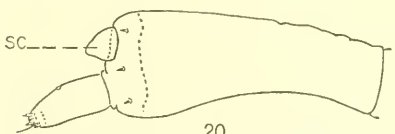
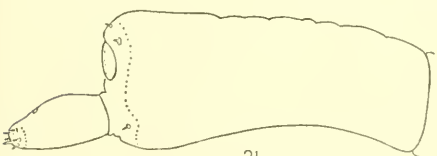
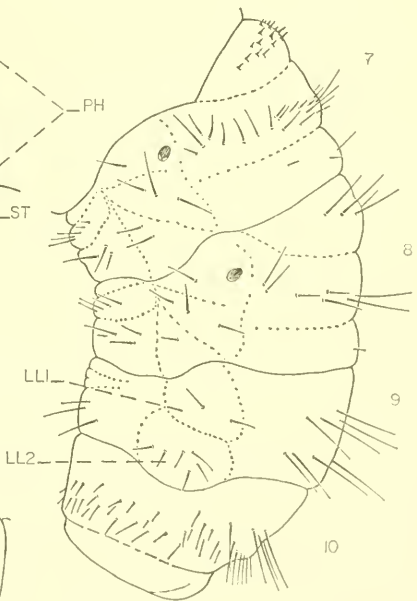
T. SORDIDUS



20 T. SONORAE



21 O. ASPER



22
T. SONORAE

Figures 23–28

23. *Trox* and *Omorgus* eggs.
    A. *Omorgus texanus* LeConte.
    B. *Trox scaber* (Linnaeus).
    C. *Trox atrox* LeConte.
    D. *Trox sonorae* LeConte.
    E. *Omorgus monachus* (Herbst).

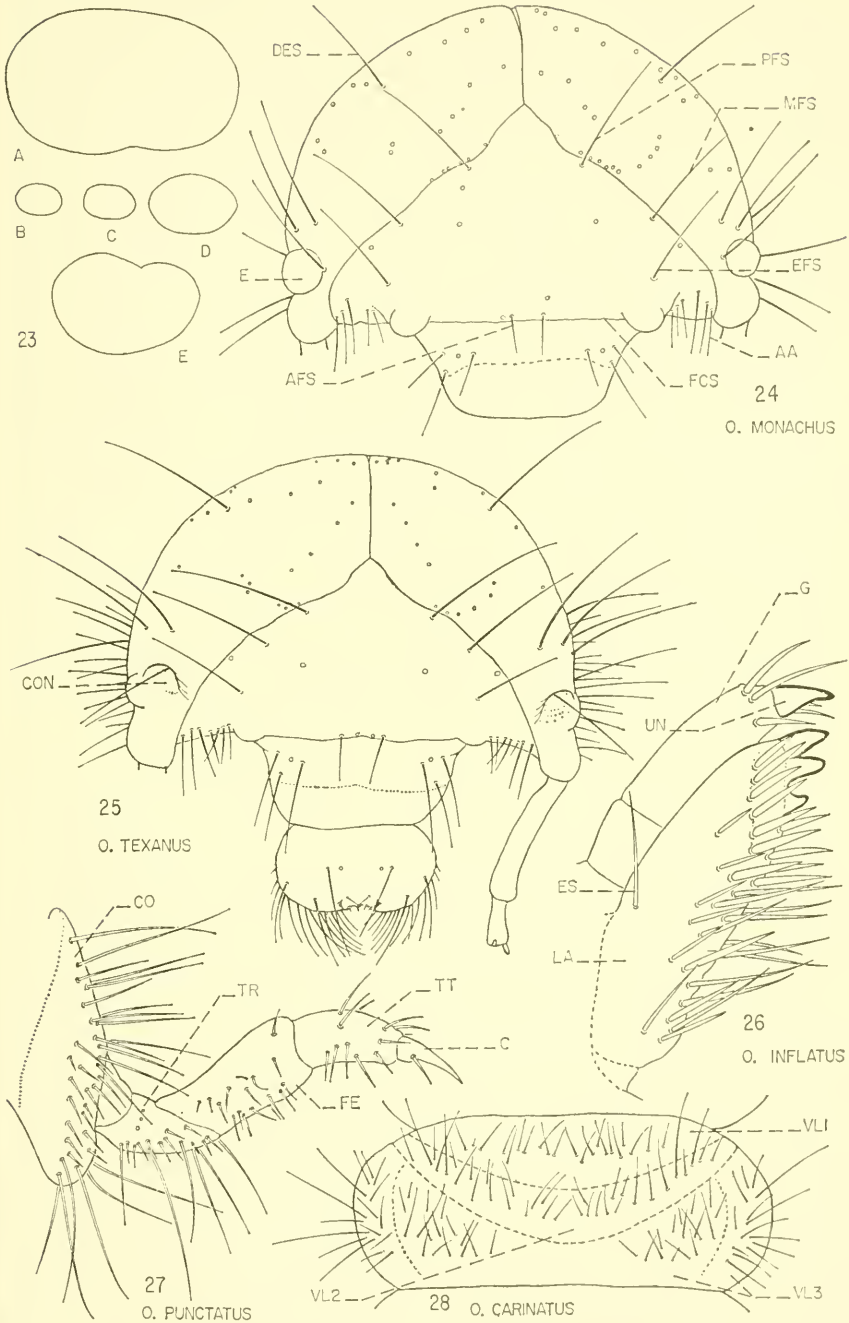
24. *Omorgus monachus* (Herbst). Head.

25. *Ormogus texanus* LeConte. Head.

26. *Omorgus inflatus* (Loomis). Dorsal aspect of galea and lacinia.

27. *Omorgus punctatus* (Germar). Anterior aspect of left metathoracic leg.

28. *Omorgus carinatus* (Loomis). Ventral aspect of segment 2 of abdomen.


A
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26
O. INFLATUS
CO
TR
TT
C
FE
27
O. PUNCTATUS
VL1
VL2
VL3
28 O. CARINATUS

Figures 29–34

29. *Omorgus fuliginosus* (Robinson). Lateral aspect of thorax.

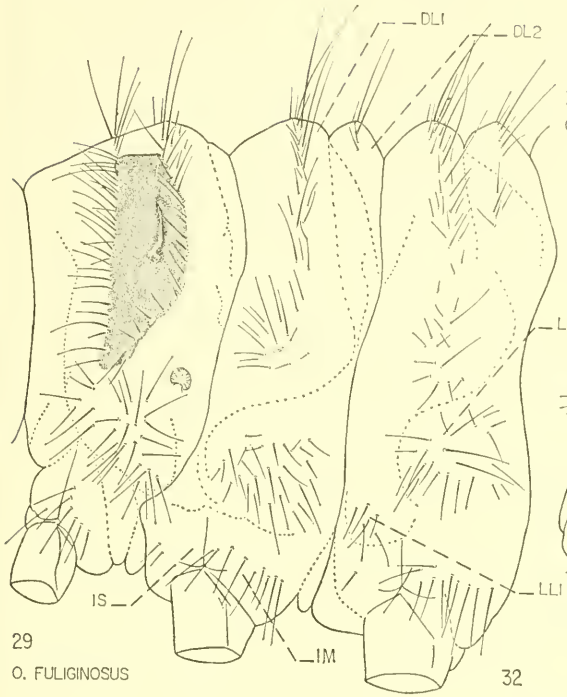
30. *Omorgus monachus* (Herbst). Prothoracic leg of pupa.

31. *Trox sonorae* LeConte. Prothoracic leg of pupa.

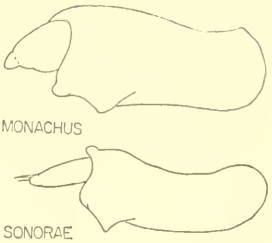
32. *Omorgus monachus* (Herbst). Dorsal aspect of pupa.

33. *Omorgus monachus* (Herbst). Lateral aspect of segments 4 and 5 of abdomen.

34. *Omorgus monachus* (Herbst). Ventral aspect of pupa.

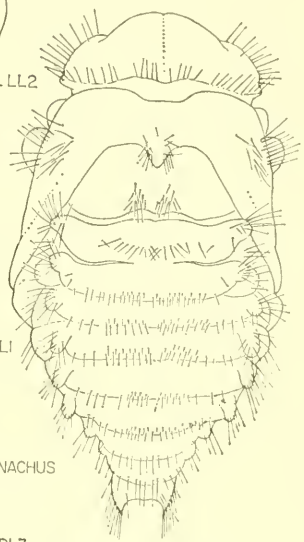


29
O. FULIGINOSUS



30
O. MONACHUS

31
T. SONORAE



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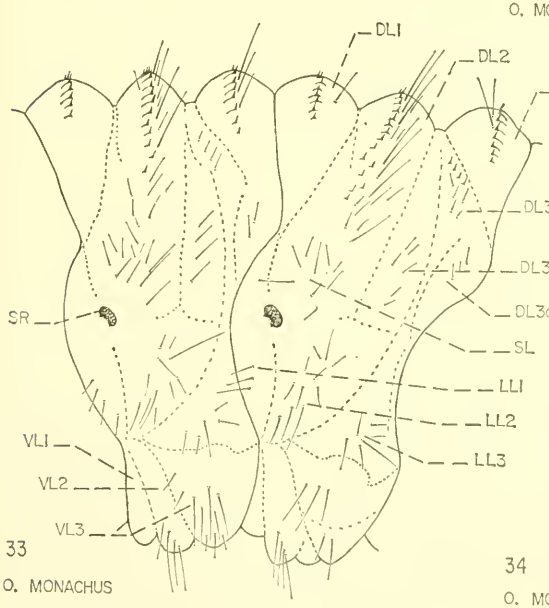
O. MONACHUS



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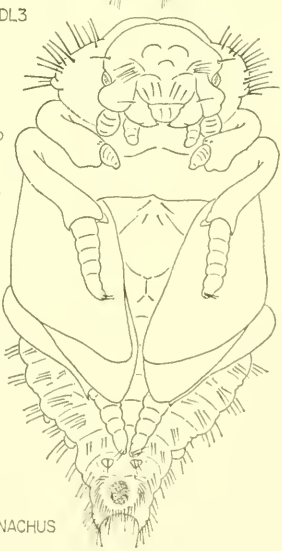


34
O. MONACHUS

Figures 35–39

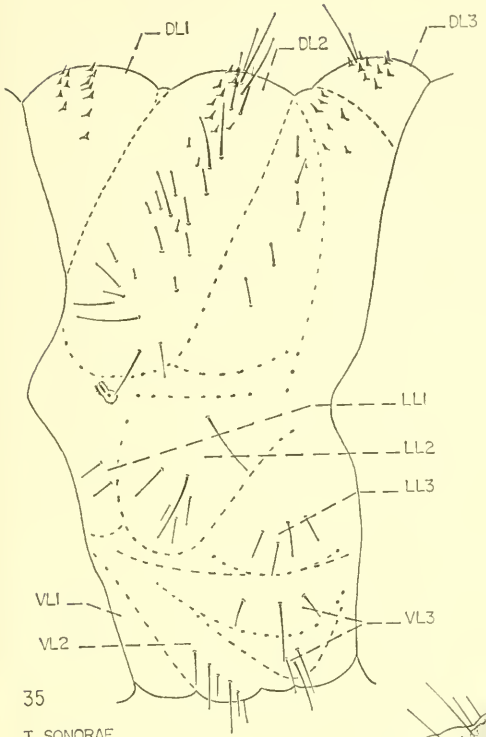
35. *Trox sonorae* LeConte. Lateral aspect of segment 5 of abdomen.

36. *Trox foveicollis* Harold. Lateral aspect of dorsal area of segment 2 of abdomen.

37. *Trox tuberculatus* (De Geer). Lateral aspect of dorsal area of segment 2 of abdomen.

38. *Trox atrox* LeConte. Anterior aspect of left metathoracic leg.

39. *Trox robinsoni* Vaurie. Lateral aspect of prothorax and mesothorax.



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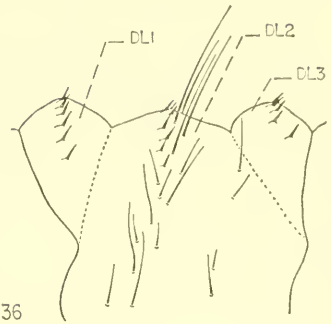
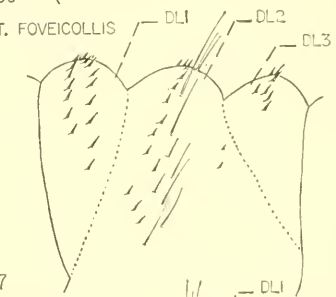
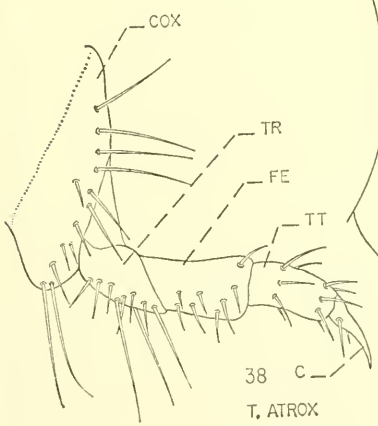
T. SONORAE



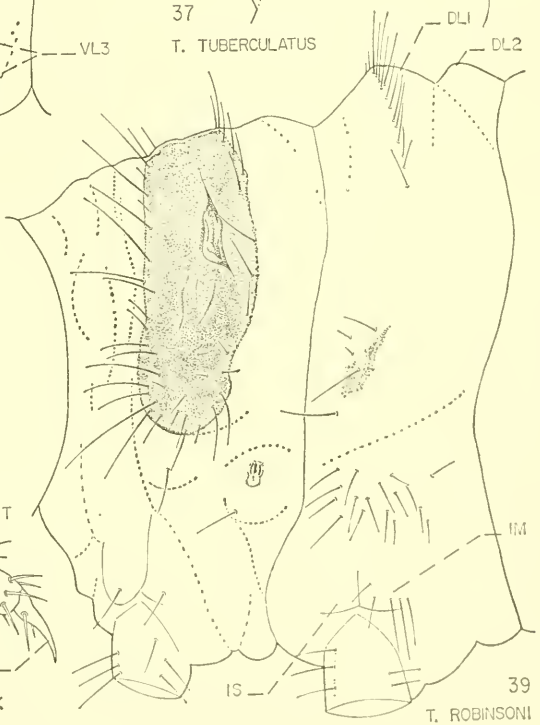
36
T. FOVEICOLLIS



37
T. TUBERCULATUS



38
T. ATROX



39
T. ROBINSONI

Figures 40–49

40. *Trox scaber* (Linnaeus). Dorsal aspect of right and left mandibles.

41. *Trox scaber* (Linnaeus). Dorsal aspect of left maxilla.

42. *Trox unistriatus* (Beauvois). Dorsal aspect of left maxilla.

43. *Trox sonorae* LeConte. Dorsal aspect of right and left mandibles.

44. *Trox frontera* Vaurie. Distal portion of terminal antennal segment.

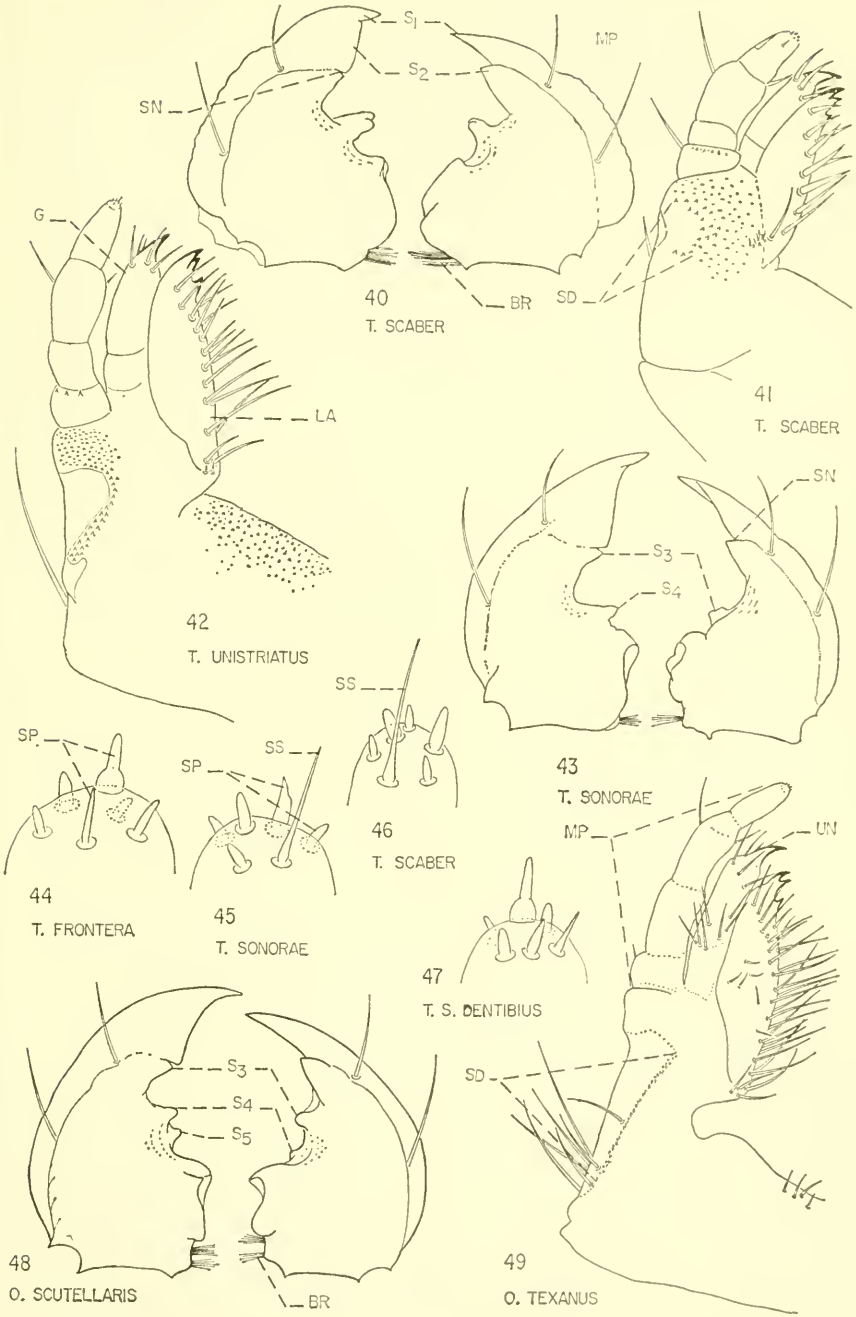
45. *Trox sonorae* LeConte. Distal portion of terminal antennal segment.

46. *Trox scaber* (Linnaeus). Distal portion of terminal antennal segment.

47. *Trox spinulosus dentibius* Robinson. Distal portion of terminal antennal segment.

48. *Omorgus scutellaris* (Say). Dorsal aspect of right and left mandibles.

49. *Omorgus texanus* LeConte. Dorsal aspect of left maxilla.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T. SCABER
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T. FRONTERA
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T. S. DENTIBIUS
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48
O. SCUTELLARIS
BR
49
O. TEXANUS

Figures 50–59

50. *Omorgus scutellaris* (Say.) Extruded rectal membrane.

51. *Omorgus scutellaris* (Say). Caudal aspect of last abdominal segment (anal lobes in nonextruded position).

52. *Trox sonorae* LeConte. Extruded rectal membrane.

53. *Trox sonorae* LeConte. Caudal aspect of last abdominal segment (anal lobes in nonextruded position).

54. *Trox aequalis* Say. Frons.

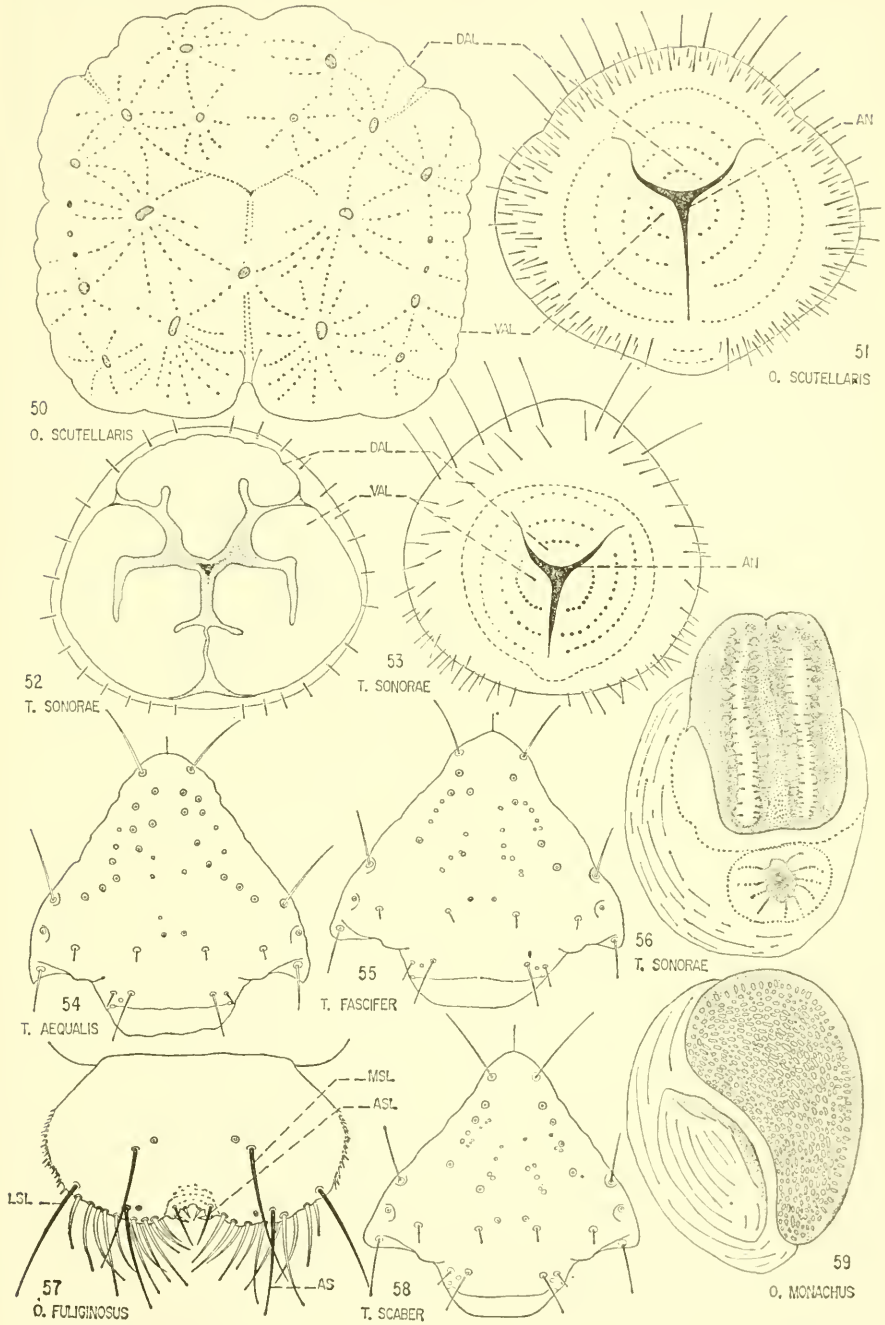
55. *Trox fascifer* LeConte. Frons.

56. *Trox sonorae* LeConte. Biforous spiracle.

57. *Omorgus fuliginosus* (Robinson). Dorsal aspect of labrum.

58. *Trox scaber* (Linnaeus). Frons.

59. *Omorgus monachus* (Herbst). Cribriform spiracle.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O. MONACHUS

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